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RECENT DISCOVERIES IN ENTOZOOLOGY.

(With a Coloured Plate.)

It cannot have escaped the attention of any well-informed reader that the subject of Entozoa, or internal parasites, is daily assuming greater importance; and this, of course, not so much on account of the very curious natural history phenomena which these singular animals exhibit, as on account of the strange part they play in the production of suffering and disease, alike as regards ourselves and the animal creation in general. In the pages of the Intellectual Observer, one of our contributors (Dr. Cobbold) has supplied us with many interesting facts respecting certain parasitic forms which infest birds, beasts, and fishes; but he has not, at present, said much about the entozoa, whose special prerogative it is to take up their abode in the human body. We have, however, lying before us an important work bearing on this subject, as well as a small brochure, by an author whose name is probably known to some of our readers.* In the larger work, which is as yet incomplete, the author enters very minutely into the structure, mode of reproduction, and general economy of the human parasites, dwelling more particularly on those species which produce fatal results.

Instructive as it might be, it is scarcely necessary to take into consideration the various steps by which the earlier entozoological observers arrived at the conviction that the little watery cysts, or *hydatids*, found in man were in reality animals; but we cannot allow the present opportunity to pass without rendering a tribute of homage to those recent investigators and discoverers in this department of science, who have, frequently at considerable risk to their own personal comfort, demonstrated the true source and nature of these lowly organized beings. To Dr. Kuchenmeister, above all others, this recognition is due, and it redounds greatly to the credit of Leuckart (who, at the present hour, is legitimately placed at the head of continental helminthologists), that he has, in the writings quoted

* "Die menschlichen Parasiten und die von ihnen herrührenden Krankheiten." Von Rudolf Leuckart. Erster Band. Liepsig, 1863.

"Die neuesten Entdeckungen uber menschliche Eingeweidewürmer und deren Bedentung für die Gesundheitspflege." Convers. Jahrb. 1863.

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below, done full justice to the physician (formerly) of Zittau. Thus, in speaking of the small cysticerci, or measles of pigs, whence we obtain one kind of tapeworm, he says:—

"Kuchenmeister hit upon the idea of administering the measles as provender to other animals, and of studying the changes which took place in the alimentary canal of the quadrupeds thus fed. Such a trial might very naturally suggest itself to any one, but this does not lessen the merit which belongs to Kuchenmeister, seeing that the result was thoroughly decisive. During the passage of the 'measles' through the stomach, they lost their caudal vesicle, which part had previously so strikingly distinguished them, the thin walls succumbing to the influence of the digestive fluids; only when the quadrupeds were proper hosts did the cephalic ends of the cysticerci resist the action of digestion. In this case they passed on, together with the contents of the stomach, into the intestines, in order to anchor themselves here by means of their sucking appendages, and also to stretch and grow into the adult tapeworm condition (Jahrb. s. 629)."

Besides these experiments on animals, it is well known that Kuchenmeister was permitted to feed two condemned criminals, to one of whom he administered seventy-five measles of pigs three days before his execution, the other having eaten twenty measles on two separate occasions, at considerable intervals. In the first case ten very young tapeworms, only a few lines in length, were found after death, and in the second experiment nineteen were found, eleven of which had advanced to the condition of maturity. Subsequently, several young men, we are told, voluntarily came forward in the interests of science, and swallowed fresh measles, and three or four months afterwards showed unmistakeable signs of suffering from tapeworm. They were, we presume, deprived of their internal guests by the employment of the ordinary remedies, when, at least, they had satisfied themselves that they had played the part of host long enough.

But it is neither the measles of pork producing the *Tænia solium* of man, nor the measle-like cysticerci of calves and oxen, producing the *Tænia mediocanellata* (equally common amongst our veal and beef-loving community); nor, again, the *Oxyuris*, vexing children; nor the *Trichinæ* of sausages and hams, and the closely allied species of *Ascarides* (which we probably obtain by drinking unfiltered water); it is not, we say, any of these forms about which we need particularly trouble ourselves just now, but it is in reference to that most fatal of all disease-producing parasites, the so-called *Echinococcus*, to which we now most especially desire to call attention.

Veterinarians, sheep-breeders, stockmasters, and others

practically acquainted with the diseases of our domesticated animals, are at length exerting themselves to ascertain the best methods by which their flocks and herds may be rendered secure from the invasion of certain of the above-mentioned entozoa; but few, if any, of their number are probably aware how much more disastrous to human life are the larvæ of a small tapeworm which lives in the intestines of the dog. In those countries where this animal is well nigh indispensable to human life, it is at one and the same time both a curse and a blessing. The tapeworm (*Tænia echinococcus*) of the dog produces a larva which annually destroys its hundreds and its thousands of the human race; and sad is it to reflect that the disease thus produced is too often, through sheer ignorance, multiplied and propagated by those who pretend to be able to cure the disease. In happy England fatal cases are of constant occurrence, but it is in Iceland that this disease assumes a formidable endemic character. According to Leuckart and Dr. Krabbe (a pupil of the recently deceased savan, Eschricht, of Copenhagen), who has specially visited the country to investigate the disease, the following facts may be relied on:—

"For every 100 inhabitants of Iceland there are 1100 head of horned cattle, and every peasant has on an average six dogs. In Denmark there are 180 cattle to every 100 of the people. There are many of the Iceland doctors who, not unfrequently, have upwards of 100 patients afflicted with the Echinococcus disease under treatment at the same time, the total number of such cases in the island being estimated at 10,000. By far the greater number of these patients, however, are in the hands of quacks, whose influence is the greater, because there are in all Iceland but *six legally authorized medical men*, each of whom presides over a district of about 1500 square (English) miles, embracing a population of about 10,000 individuals. The treatment of the quacks is exactly suited to keep up the epidemic, for, *amongst their remedies, dog's urine and fresh dog-excrement* play a conspicuous part. (Jahrb. s. 654.)"

These statistics are truly appalling! We have here a forcible illustration of the falsity of the proverb, which says, "Where ignorance is bliss, it were folly to be wise." Would it be folly to get up a Social Science Congress at Reikjavik, and, in the name of humanity and intelligence, appeal to the Icelandic parliament to put down these evil practices with the strong arm; at the same time taking every opportunity to enlighten this grossly ignorant population? Superficial, good-natured *unintellectual observers* may look on complacently, and even, perhaps, remark that the Echinococcus epidemic is one of those mysterious dispensations of Providence which we ought to accept submissively, without looking too minutely into the

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secondary causes concerned in its production. For our part, however, we prefer to read His guidings differently, to sound the aforesaid causes to their lowest depths, to search out the animal parasite which thus afflicts mankind, to subject the little beast to microscopic examination, to watch its growth and development, to work out its anatomy, to study its haunts and habits, to make it the source of a series of experiments; in short, to leave no stone unturned by which we may arrive at a sound conclusion as to the best methods of checking its abundance, and of preventing its destructive assaults upon the welfare of our fellow men. An enlightened public will eventually applaud these efforts; but, as in a crowd, it is only the tallest men who see furthest, so, unfortunately, does it happen that our laborious, self-denying, experimental physiologists gain only the respect of the few; whilst the many, unenlightened, prefer the "old paths," not unfrequently, indeed, placing every obstacle they can in the way of those who silently devote their time and talents to studies which are calculated to benefit us all. If it were necessary to exemplify the truth of these remarks, we should refer to the recent attacks made upon experimental physiologists in reference to the question of vivisection, and other investigations demanding the destruction of the lower animals.

One-sixth of the annual deaths among the population in Iceland are solely owing to the Echinococcus entozoon, and shall we therefore refuse to permit the helminthologist to continue his experimental inquiries on the score of cruelty to animals? As a shrewd writer in the pages of the *Examiner* has recently very justly remarked, we have now arrived at a time when "every abomination has its zealous and thorough-going advocate."

The little entozoon producing the disease referred to has this singular peculiarity about it, namely, that in the adult or mature condition it scarcely attains a length of one-sixth of an inch, whilst in the larval, imperfectly developed, or so called hydatid condition, it may grow to the size of a man's hat. In the adult state it is a minute tapeworm, with four joints, and a single head, armed with four suckers, and a double crown of hooks; whereas, in the larval condition, it presents an aspect not unlike those toy air-balls which children play with. This globular hydatid is furnished with hundreds, nay thousands, of heads, each one of which is capable, under favourable circumstances, of becoming a tapeworm. The adult worm, as we have said, lives in the intestines of the dog, whilst the death-producing larva infests man and herbivorous animals of the domesticated kind.

To render our description more suggestive, we beg to direct

attention to the accompanying plate, for which we are indebted to Dr. Cobbold, who is at the present time engaged in preparing a new work on the entozoa of man and animals. He has also supplied us with the following explanatory references, which supersede the necessity of our entering into a more minute description of the worm. This entozoon will, doubtless, be more fully described in his forthcoming work:—

Explanation of Plate.—Fig. 1. Juvenile echinococcus—hydatid, about six weeks old (× 50 diam.). From a specimen reared by Leuckart, and now in Dr. Cobbold's collection. 2. Portion of a large Echinococcus hydatid from a cyst in the human liver. From a specimen in the Museum of the Middlesex Hospital, Dr. Murchison's case. Coloured naturally by the bile. 3. Similar portion of an hydatid, artificially coloured with magenta. Dr. Greenhow's case. Specimen preserved in the same museum. 4. Echinococcus-scolex, or head with the hooks and suckers displayed, from a zebra (× about 500 diam.). After Huxley. 5. Two of the hooks separated; one seen in profile, the other in front. After Huxley. 6. An entire sexually mature *Tænia echinococcus*, shewing the head, rostellum, suckers, and the three succeeding segments, the last of which is the largest, and contains the ova and other reproductive elements (× 30 diam.). From a specimen prepared by Leuckart, and now preserved in Dr. Cobbold's cabinet.

Having said thus much about the entozoon, and the disease it produces, one naturally desires to know what methods are to be adopted in order to quit ourselves of these ugly little customers. In the present state of our science we are not, perhaps, entirely able to bring about the total abolition of this terrible hydatid disease, but, at all events, the suggestions of Drs. Leuckart and Cobbold show us the way in which we may check it to a very noteworthy extent. We shall, therefore, allow these gentlemen to speak for themselves:—

"In order to escape the dangers of infection, the dog must be watched, not only within the house, but whilst he is outside of it. He must not be allowed to visit either slaughter-houses or knackeries, and care must be taken that neither the offals nor hydatids found in such places are accessible to him. In this matter the sanitary inspector has many important duties to perform. The carelessness with which these offals have hitherto been disposed of, or even purposely given to the dog, must no longer be permitted, if the welfare of the digestive organs of mankind are to be considered. What blessed results may follow from these precautions may be readily gathered from the consideration of the fact that, at present, almost the sixth part of all the inhabitants annually dying in Iceland, fall victims to the echinococcus epidemic. It is true, that nowhere

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else, probably, are the conditions for the development or, rather, the transportation of the echinococci, so favourable as in that country. The dog being not only of far greater importance to the Icelander than he is to us, is, consequently, much more generally kept. Another circumstance, also, must be held to weigh very heavily, namely, that almost everybody in Iceland keeps his own stock of cattle, and lives, during the long winter nights, with the entire living stock, usually huddled together in a very small space. Moreover, that cleanliness which we know to be one of the most important preservatives against infection, is but too often wanting in those parts." (Jahrb. s. 654.)

In reference to the same subject, Dr. Cobbold, in his paper partly read at the Cambridge meeting of the British Association in 1862, and afterwards more fully communicated to the Zoological Society,* writes as follows:—

"My friend Dr. Leared has ingeniously suggested that every dog should be efficiently physicked at a certain given time, and that all the excreta, tapeworms included, should be buried at a considerable depth in the soil. The experiment should be extended over several seasons. The mature *Tæniæ* thus destroyed would, it is conceived, cut off the supply of embryos and *Echinococci*, and the endemic might thus be averted. To this suggestion I would add, that in place of burying the excreta, *they should, in all cases, be burnt.* If this latter suggestion be not carried out, it is more than probable that multitudes of the minute embryos will escape destruction, and ultimately find their way into the human body. I have previously urged this preventive measure (in my paper 'on the *Sclerostoma* causing the gape-disease of fowls,' published in the Proceedings of the Linnean Society for 1861), with the view of lessening the prevalence of other entozoa, both of man and animals, and I again invite attention to the importance of observing this rule. *All entozoa which are not preserved for scientific investigation or experiment should be thoroughly destroyed by fire, when practicable, and under no circumstances whatever should they be thrown aside as harmless refuse.* In the case of the *Tænia echinococcus*, the greatest difficulty likely to be experienced lies in the fact of the extreme smallness of this tapeworm. As an additional security, therefore, I would recommend that boiling hot water be occasionally thrown over the floor of all kennels where dogs are kept, for, in this way, not only the escaped tapeworms, but also the little free embryos themselves would be effectually destroyed."

* "Remarks on all the Human Entozoa." By T. Spencer Cobbold, M.D., F.L.S., Lecturer on Compt. Anat. at the Middlesex Hospital.—*Proceed. Zool. Soc.* for 1862; vol. xxx., part iii., pp. 288—315.

A DAY WITH THE FIELD CLUBS.

BY THOMAS WRIGHT, M.A., F.S.A.

Perhaps many of our readers will hardly know what a Field-Club is, although, during the last few years, this sort of society has become very fashionable in some parts of our island. Natural History Societies have existed long in almost every country town, and they have established museums, and, from time to time, listened to lectures; but the field-club presents a different and a pleasanter method of studying science. Gentlemen, and ladies too, form themselves into a society for the purpose, not of sitting on benches in a close room to listen to a lecture, but of meeting at a pre-appointed locality, and of strolling together during a long summer day over the country around to explore its geology, its botany, its natural history, or its antiquities. Particular districts must, of course, be more congenial than others to associations of this description; and among these favoured districts stand foremost the beautiful counties on the borders of Wales, in which apparently the idea of field-clubs originated, and where they are still more numerous than in other parts of the island. The first of which I have any knowledge was the Woolhope Club, which was established partly by the exertions of the late Rev. T. T. Lewis, and of which his friend Sir Roderick (then Mr.) Murchison was one of the earliest members. Woolhope is a parish in a very picturesque part of Herefordshire, the country around which possesses great interest for the geologist, and hardly less for the botanist; but the original object of this club was to explore the geology of this particular district. Gradually the Woolhope club abandoned geology to a considerable degree and devoted itself to botany, and at one time went so far as to offer prizes to its members for the discovery of plants of unusual rarity. The idea of these clubs next passed the border of this county into that of Worcester; but the Worcester Field-Club assumed more the character of a Natural History Society. At a subsequent period a field-club was established at Malvern, which has met with considerable success, and set the good example of forming a museum for its collections. The taste for these clubs extended from Worcester in two directions—southward into Gloucestershire, where the Cotswold Field-Club rose into existence, a small and rather aristocratic body, and northward to the mineral districts on the Staffordshire border, where quite recently a field-club was formed at Dudley, which is the most numerous society of this class yet

established. In Shropshire these clubs are of very recent date. There is one at Ellesmere, which, like those of Dudley and Malvern, is forming a museum; and another at Oswestry, close upon the Welsh county of Denbigh. Two other Shropshire field-clubs, the Severn Valley Club and the Caradoc Club, which have been formed during the present year, have distinguished themselves by their energy and activity. The former has for its special field the district from which it takes its name and the Wenlock Mountains; the other has its head-quarters at Church Stretton, between the mountain ranges of Caer Caradoc and the Longmynd. Although, however, these clubs belong properly to particular districts, they have adopted the custom of fraternizing occasionally, and holding joint meetings at places of special interest. Thus, on the 7th of July in the present year, the Caradoc, Woolhope, and Oswestry Clubs held a joint meeting at the Craven Arms in Shropshire, and explored together the interesting district of which that place is the centre; and on the 13th of August, the Caradoc and Severn Valley Clubs joined in a meeting at Church Stretton. It was at this latter meeting that I attended.

It was one of the hottest days—perhaps the hottest—of this unusually fervid month of August, when, on the morning of the 13th, I took a forenoon train from Shrewsbury, with a number of companions bent on the same errand. We soon approached the entrance to the beautiful Stretton valley, overlooked by the lofty mass of Caer Caradoc, which, seen in this direction, rises on one side somewhat in the form of a vast sugar-loaf, and stands here like a permanent sentinel on guard over some enchanted region. Caer Caradoc, on this side, appears to most advantage when seen from the railway, a little to the south of the Dorrington station. A few minutes more and our train left us at the Church Stretton station, where we were soon afterwards joined by another body of our associates, who came by the train from the south.

Church Stretton is a picturesque town, seated at the foot of the Longmynd range, which forms the western side of the valley, and nearly opposite Caer Caradoc, which, with the range of mountains out of which it rises, and which are known collectively as the Stretton Hills, forms the limit of the valley to the east. At the bottom runs the ancient Roman road from Uriconium (*Wroxeter*) to Magna (*Kenchester*) and South Wales, now called the Watling Street, and still forming part of the high-road from Shrewsbury to Hereford. Through the valley, which is watered by numerous little trout streams, sparkling in the sunshine as they wind their course through pleasant meadows and copses, this ancient road runs nearly parallel with the railway, and may frequently be seen from it. Geologically this

district is full of interest. Church Stretton itself is situated nearly on a very remarkable line of "fault," which extends all along the base of the Longmynd Hills, and by which the strata, once horizontal, have been so completely disturbed that on one side of this line the ancient Cambrian rocks are now tilted up almost perpendicularly, while on the other the much more recent Wenlock (or, as some suppose, Ludlow) and Caradoc rocks repose against them in a far more horizontal position. This displacement has manifestly been accomplished by the pushing up of the strata to the west of this fault; and the unconformity is considered by Professor Ramsay to amount to two thousand feet. This powerful dislocation was probably connected with the volcanic action of which the Caradoc and its neighbourhood present so many traces. The rocks of the Caradoc have been submitted to far greater heat than has acted upon the Cambrian rocks, which occur much lower in the order of the strata; so intense indeed has been the igneous action that all traces of fossils have disappeared, though the lines of stratification, which identify them with other rocks in which fossils abound, are preserved. Igneous action is, of course, closely connected with volcanic action, and it is a remarkable circumstance that this line of "fault," on the eastern side at least, continues to the present day subject to those shocks of which we have lately had so notable an example. It is even stated that in Ludlow, which is divided by a well-known "fault," the earthquake was felt considerably on one side of the town, while the other part was comparatively exempt from it.

Soon after eleven o'clock the members of the united field-clubs and their friends, who had assembled at Church Stretton, proceeded from the railway station on their way to Caer Caradoc. The mountain presents on the side towards the high road, that is, on its western flank, a declivity so steep that the ascent is almost impossible; but by a lane, which turns out of the road from Church Stretton by way of Hope Bowdler towards Wenlock, and leads up through the elevated valley between Caradoc and Hope Bowdler hills, we reach a spot where, though the ascent is still very difficult, it is somewhat less abrupt, and the distance to the summit is considerably less. A few of the party, who were unwilling to encounter the fatigues of the longer excursion to which the printed programme invited us, separated from the rest soon after leaving Church Stretton, and followed this short and direct road to the mountain; but the greater part chose the way to Hope Bowdler. This road, for nearly a mile, presents a gradual ascent, and we proceeded but slowly both from this circumstance and because the attention of the visitors was continually arrested by the imposing masses of the Caradoc, Lawley, and Hope Bowdler hills before

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us, and by the still greater beauty and the continually changing variety of the prospects presented behind us by the Longmynd hills as they backed the town we had left; and some gathering clouds, which threatened a thunderstorm at this moment, added greatly to the beauty of the latter by the bold contrasts of light and shade which were suddenly thrown over them. Passing through the turnpike gate at Hazlar, a little more than a mile from Church Stretton, we soon reached the village of Hope Bowdler, somewhat less than a mile further. Along this road the first objects of interest were occasional quarries of metamorphic rocks—the ancient Caradoc sandstone altered by heat; and at Hope Bowdler we saw a layer of conglomerated pebbles, water-worn, slightly stratified, but not in a horizontal direction, and reposing on the highly-inclined edges of Caradoc strata. Such layers are wonderfully interesting, for it is through a careful study of them that we may hope to trace the history of these primeval rocks and of the marvellous changes which have taken place during and since their upheaval. A single pebble in such a stratum tells a long history in itself. It was once a component part of previously existing rocks, was torn from them by the action of mighty primeval forces, was rounded by rolling hither and thither on the shores of ancient seas, and was deposited at last, with other similar pebbles, in the bed in which we now find it resting. During this time the rocks on which we find it thus reposing were subjected to immense heat and pressure, and were afterwards raised from their original horizontal position into one highly inclined; and when we consider the slow progress of such operations as they are effected in the present day, our minds feel confounded at the contemplation of the immense periods the workings of which lie thus displayed before us.

From Hope Bowdler we turned south, by a lane which, at the distance of about half a mile, brought us to the rather extensive quarries of Soudley, interesting for their good display of the lower Silurian fossils, but still more so as being the key-note from which the wide scale of the Silurian system appears to have been struck off. This quarry is worked in the uppermost strata of the Caradoc sandstone, presenting a face of about a hundred feet in thickness, in which beds of good freestone alternate with layers of sand, and of a softer stone, in which the best fossils are found. Upon this latter stone the visitors employed their hammers very energetically, to the great astonishment of the quarrymen, who were working the stone for very different purposes; and the former soon collected specimens of rare fossils, such as the diplograpsus, the simplest form of the doubly-serrated graptolites, fossils distinctive of the lower Silurian rocks, which do not vary much in

England, but are eccentric enough in the specimens from Canada and Bohemia; while orthis of many species, strophomena expansa of large size, tentaculites, leptœna sericea, and many other shells, were easily found, along with joints of encrinites and fragments of the beautifully-dotted trinucleus Caractaci, a perfect specimen of which is rarely met with. This spot presents the Caradoc strata in their simplest form, unaltered by heat or distortion, and left behind by the vast force of igneous action which has raised the same rocks in an altered slaty condition to the summit of Snowdon, and by which also this picturesque chain of hills which we were now going to visit, and of which Caer Caradoc is the chief, was protruded. The work of geological hammers was suspended for a moment to listen to a popular lecture on these Silurian rocks by the excellent Vicar of Stokesay, the Rev. J. D. La Touche, one of the most active leaders of the field-club movement in Shropshire, and to some further remarks by Mr. Lightbody, the eminent geologist of Ludlow; after which we proceeded to retrace our steps in the direction of Caer Caradoc.

At Hope Bowdler the party had been joined by those members of the Severn Valley Club who had driven across the country in carriages of various descriptions, and it had now become numerous, amounting, as it was said, in all, to about a hundred and eighty, of which a considerable majority consisted of ladies. We may well suppose that such a sudden invasion of the hill districts must have caused no little surprise among its scattered population; and this was displayed in one or two rather amusing incidents. At one place in the road, an old woman and her husband, looking out from their cottage door, expressed their views on the subject loud enough to be very distinctly heard. "Who may they folk be, dun ye think?" asks Darby of his faithful Joan. "Oh!" replies Joan, who was evidently of a literary turn of mind, "why, they be the pilgrims you read of in books, sure enough they be a-going a pilgrimage." In fact, she took us for some of the numerous personages immortalized in the pages of the "Pilgrim's Progress." And one of our fair companions afterwards remarked that we had indeed come to "the Hill Difficulty," and confessed to having found it "very toilsome in the ascent, and somewhat slippery."

Towards this difficult hill the whole party now proceeded, as the special object of this meeting was to study the curious and instructive dislocations of the earth's crust which were there brought to view. On the way, specimens of almost every variety of igneous material were met with among the *débris* rolled down from the sides of the mountains—porphyries, hard and bright-coloured as those of Egypt; red and grey jaspers,

greenstone, white and pink quartz, and many rarer minerals. The mass of the rock is felspathic, like that of Malvern, with tufaceous heaps of half-burnt cinders, and sandstones and conglomerates changed by heat into shattered quartzose and granitic blocks. Attracted by the prospect of a pleasant country lane, and in the expectation of making a short cut to Caer Caradoc, I had turned off from the road with a small party, immediately after repassing Hazlar gate. We enjoyed for some distance the rural character of the road we had thus taken; but we soon found, that instead of easing our walk, we had to pass over the ridge of an intermediate, though not very elevated hill, and our progress was rendered somewhat difficult by the luxuriance of the ferns which covered it. On our way up, Hope Bowdler hill presented a bold mass on our right, stretching out from the south-west to the north-east nearly parallel with Caradoc, and we had a very distinct view of the singular object on its side, which the peasantry call the Battle Stone; and they tell us in their legendary traditions of sanguinary engagements which took place in this valley, and how the prisoners were carried up the hill to be beheaded on this stone—it being then, of course, the custom thus to treat any unfortunate captives. The stone is a porphyritic mass, with red stains, which seem to have suggested to the popular mind these tales of slaughter. The descent of the hill we had to pass was found steeper than the ascent, and it was uncomfortably marshy at the bottom; and we had to cross a marsh and a stream before we stood in the middle of the valley, with the mighty mass of Caer Caradoc before us. This place of meeting had, as it will have been already seen, been fixed entirely on its geological claims, for the district over which we were wandering presented no great interest to the botanist, and not much to the archæologist. The faces of the hills are covered mostly with rather stunted gorse, heather, and wild thyme, sprinkled over with the blue hairbell, and there are few plants of any rarity. The *Drosera rotundifolia*, or sun-dew, is said to be found in these marshy spots at the foots of the hills, though if so, it is very rare; but the *Pinguicula vulgaris*, or butterwort, an exquisitely beautiful purple flower, grows here abundantly.

The Caradoc range is, as already indicated, a mass of extremely abrupt mountains running from S.W. to N.E., highest at its north-eastern end, where Caer Caradoc rises to an elevation, according to the ordnance survey, of full 1200 feet above the level of the sea. The elevation is most considerable from the plain on the west, on which side its summit is almost inaccessible, but on the eastern side it is less elevated, because it rises from an elevated valley; nevertheless, especially on such a sultry day as the 13th of August, it required both courage

and strength to venture up it. The heat of the sun had dried up the scanty grass which covered its surface, and had rendered it so slippery that it was almost impossible to stand upright on the side of the mountain; and it was only after a long struggle, and a combination of springing up and slipping down, with an occasional moment of rest, by taking advantage of some small, stunted bush of gorse, that the visitors, weary and exhausted, reached the summit. Like provident pilgrims, most of them had contrived to carry some amount of refreshments, which they here found exceedingly welcome, as they gazed on the magnificent scene around. The top of Caer Caradoc forms a very uneven area, of no great extent, but surrounded by an ancient double entrenchment; for what purpose it would be in vain to attempt to decide with our present knowledge. Many of our old antiquaries and historians, who had evidently never seen it, set it down very absurdly as the site of the last battle of the British hero, Caractacus; though its position is anything but a convenient one for any kind of military operations. It is more probably a burial-place, for we know how much the primitive peoples loved to inter their dead on the summits of lofty hills; and, at a hasty view, there appeared to be some traces of what may have been sepulchral tumuli. The view from the top is, as we have just stated, grand and varied; and those who, coming direct from Church Stretton, had mounted earlier in the day, had been able to enjoy it with a clear sky; but afterwards, as one of the results of the extreme heat, the distance became more and more concealed in a hazy mist. This was the case especially on the side towards the north-west, where a clear distance was above all things necessary to exhibit in its full beauty the vast panorama presented by the vale of Shrewsbury and the country for an apparently interminable distance beyond. Towards the east, however, we could distinguish tolerably well through the mist the long line of the Wenlock Edge, extending north and south for nearly twenty miles, and appearing over it at intervals a second ridge, called the ridge of Aymestrey limestone. Between them intervenes a valley worn in the soft shale, which lies between the Wenlock and Aymestrey limestone, by the action of those mighty currents which once washed over the whole area on which we stood. Had there been no mist we should have seen in the distance, behind the Wenlock and Aymestrey lines, a third, composed of Old Red Sandstone, and the view would have been bounded in that direction by the two Clee Hills, which are composed of mountain limestone and the coal measures. Towards the west the great mass of the Longmynd presented itself, running parallel with the lines of hills just mentioned; but, as stated before, a long line of "fault" has

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brought the Caradoc strata into juxtaposition with the Cambrian; and thus, as the geologist is aware, a vast stratum called the Llandeilo is unrepresented on that side of the Longmynd; it lies, in fact, deep down under Church Stretton. On the other side of the Longmynd, however, it is found largely developed.

In thus looking over the country around we could trace the various layers which compose the Silurian rocks from their base upwards, and the regularity of their succession; the distinctness, indeed, with which it is marked in that neighbourhood is most striking, and leads us to the conviction that, once on a time, piled high above the ground on which we stood, this vast mass of strata, measuring fourteen English miles and a-half deep, stood accumulated; that gradually a great crack (the "fault" before named) occurred; and that in the upheaval the Longmynd side outstripped the other; that over the surface of this area, probably during the whole time it was being gradually raised above the bed of the ocean, the waters rushing to and fro denuded the higher parts of the dome; and that we now trace in the ridges contemplated from the top of Caer Caradoc the materials of the shell which has thus been so curiously formed and laid bare. Ancient Caradoc still bears on his shoulder a sample of the material covering which once lay over him. A very small party descended—and they were obliged to do it in a most undignified position—the almost perpendicular slope of the west side of the Caradoc, to where a huge mass of the Aymestrey rock is found reclining at a very high angle; which, by its great hardness, being detached, has remained there as a witness of the continuity of the stratum which once extended over the whole area. The thrusting up of the Longmynd range has given us the opportunity of examining the various layers, from what is believed to be the first deposit on the earth's original surface, for the lowest of these strata have been regarded by geologists as the earliest deposited rocks, the most ancient part of the outer crust of the earth. The shales of the Longmynd contain the first traces of life, the Arenicolæ, and display the marks of the ripples of primeval tides, and even casts of raindrops, on the thin layers composing the strata.

Before this descent, however, the formal meetings of the two clubs, severally, had been held on the side of the hill-top which looked over the valley eastward, and their routine business had been proceeded with; after which, while the listeners reposed themselves in groups on the sod around, a short lecture on the ancient tumuli of the district was delivered, in fulfilment of a promise, by the writer of the present paper. The small party who had visited the mass of Aymestrey rock on the western flank of the mountain continued their laborious descent

on that side, and returned to Church Stretton by the Roman road, the Watling Street. The rest descended gradually the same side they had gone up, and after a pleasant walk down the valley, reached Church Stretton to partake with the others of a well-furnished cold dinner, after which the rector of Church Stretton, the Rev. H. O. Wilson, threw open to the visitors the beautiful and very extensive and ornamental grounds attached to the rectory, which extend up some of the lower slopes of the Longmynd, and formed a very pleasant spot for meeting and conversation after the labours of the day. To those who had returned by way of the Roman road more objects of antiquity had presented themselves than had been seen in the earlier part of the day, and on one of the slopes of these pleasure-grounds I read to them a paper on the Roman roads in Shropshire. The evening was already advanced when I left for Ludlow, quite convinced that the meeting of a field-club is a very agreeable, as well as a very intellectual and instructive, manner of passing a summer's day.

METAMORPHISM.

BY PROFESSOR ANSTED, M.A., F.R.S.

If the reader be alarmed at a title so technical as the word Metamorphism let him examine the first piece of Portland or Bath stone that comes in his way, or let him go to the nearest quarry or brick-pit and look at the state of the mineral substances there laid bare. Let him further consider that these stones and clays must certainly have once been mere heaps of shelly sand and mud, confused and impalpable, and that to bring them into their present state they have undergone no external change. Operated on no doubt by the great silent forces of nature that are everywhere present, they also bear no marks whatever of any special modification of structure. He will not fail to perceive that great change has been produced, that shells have become altered, the original material being displaced by crystalline carbonate of lime, that nodules have formed in the clays, that each limestone has a structure of its own by which it may be distinguished from other limestones, and in a word he will everywhere see proofs of some curious transforming agency for which a name is desirable. Let him call this agency *metamorphism* and the change a *metamorphosis*, that he may be able conveniently to examine, discuss, and understand the alterations that take place in rocks without affecting their external form.

Should he be able to visit large quarries or observe those

crevices and fissures more or less filled up with foreign ingredients that characterize certain districts, he will find still more striking examples of change in the arrangement of the atoms of various substances quite independent of any change of external form. He will find calcareous shells becoming siliceous, still retaining their minute structure; trunks of trees also silicified, from which he can get slices for the microscope that will exhibit all the details of organization; hollow flints and other stones, with a perfect lining of the most beautiful crystals.

If he visit Wales and Cornwall, and can examine slate quarries and places where such rock as granite is worked, he will find structure so new and peculiar, so complicated and so curious, that he will fancy himself studying the remains of another world; he will then begin to think of molten rock penetrating into and altering the other rocks; he will dream of the deep recesses of the earth where abundant stores of fluid granite are always ready at hand to perform nature's miracles; where all the marvellous phenomena of volcanoes are prepared, and where, in fact, having reached Vulcan's workshop and nature's laboratory, he is at liberty to amuse himself with all the explosive compounds, the great furnaces, the powerful acids, and the overwhelming forces he believes to exist there, and thus settle all the difficulties of geology at one effort. It would be strange if with all these facilities of producing disturbance, our adventurous, but still dreaming student, did not give way to temptation and return from dreamland a confirmed Vulcanist, referring every disputed point to some result of the action of fire on the materials beneath his feet, knowing nothing whatever meanwhile of the condition of the earth's interior, of the mode in which rocks are changed, or of the connection between volcanic phenomena, which are really igneous, and those that have produced granite and modified clays and limestones at great and unknown depths beneath the earth's surface.

The earlier geologists were, in fact, in the position here indicated, and have behaved in a manner not very different from that of our dreaming student, and their dreams have unfortunately been accepted as sound conclusions, occupying a prominent place in most popular works on geology of the present day. There has been a long and hard struggle for many years to found another school of geology to question nature a little more closely as to her style of work in reference to these altered rocks, without these gratuitous assumptions, and to put aside as a matter to be inquired about and not taken for granted, the influence of intense melting heat in the interior of the earth, within those narrow limits that come within human observation, and which alone have been concerned in the work of metamorphosis.

The condition of the earth's interior can never be known by direct investigation. The deepest mine is not nearly three thousand feet below the surface, not a fifth part of the amount of the inequalities either of mountain or ocean. Within that depth there are no doubt indications of a gradual increase of temperature, but it is quite unsafe to assume that this change continues or that it is connected with any uniform increase towards the centre, as it may be purely superficial in every important sense of the word. Volcanoes are phenomena which no doubt indicate that in certain districts and under certain conditions there is a disturbing force at work beneath the earth's surface, and that a high temperature exists at the moderate depths at which volcanic action seems always to originate.

But all this is a very small scintilla of evidence on which to base so important a conclusion as that the interior of the earth is in a state of igneous fluidity. The skin we can examine is a film so thin in proportion to the diameter of the earth that it does not correspond to more than the coat of varnish on a three-foot globe.* It cannot possibly justify any deductions as to the state of the interior, since even the phenomena of volcanic action are local. The only real evidence on the subject is derived from investigations purely physical. Thus by an elaborate calculation, the details of which will be found in the *Philosophical Transactions* for 1857, Mr. Hopkins concluded that the increase of temperature in deep mines cannot be due to any such cause as central heat. Long before this the same mathematician had shown that the earth could not have a fluid nucleus approaching within several hundred miles of the surface, and very lately one of our most distinguished physicists, Professor W. Thomson, of Glasgow, has shown the probability that unless the earth were more rigid than steel to a depth of at least two thousand miles, it could not maintain its figure against the tide-producing forces of the sun and moon so as to allow the phenomena of the ocean tides and of precession and nutation to be as they are.†

Putting aside then for the present the assumption that the earth has once been in a state of fluidity from heat, that it has cooled down gradually until a thin film has formed on the surface, and that this film has since been cracked and the fissures filled from the molten sea of fire below, let us endeavour to seek for some explanation of known phenomena without this hypothesis, and, if possible, without any preconceived notion or theory whatever. Let us consider the state of the earth's outer film, or crust, the changes to which it is subjected, and

* Three thousand feet corresponds to 1-200th of an inch on a three-foot globe.

† *Proceedings of Royal Society* for April 14, 1862.

the relation that these changes seem to bear to laws that we can study, and forces that we can measure.

The work that goes on near the earth's surface takes its origin at the contact of earth, air, and water, and the action of water and weather upon all exposed rocks is constantly tending to grind and pare away inequalities. Thus there is a never-ceasing piling up of mud, and stones, and sand, in the great expanse of the ocean, but especially near the shores, where the waves are always beating, and towards which the rivers bear their tribute. Marine currents spread this over the sea bottom, and with it is mixed a vast, but very variable quantity of organic matter, either bones, teeth, shells, corals, or the microscopic cases of animalcules, according to circumstances and conditions which we can occasionally study, but with which we are not perfectly familiar. The rate of such accumulations over the whole earth must certainly be very large every year, and if there were no counteracting cause, the result would in time reduce the land to the merest shreds and patches of the hardest rock.

But that there is some counteracting cause is certain, for its results are traceable without much difficulty. In many parts of the earth there are movements of elevation or depression—limited, no doubt, at present, to definite areas, and, perhaps, not unconnected with those districts where earthquakes are felt, and where volcanoes cast out from yawning cracks in the earth volumes of steam, fiery floods of lava, and thick clouds of ashes. Very slow are these movements, but, perhaps, not much slower than corresponds with the amount of accumulations at the sea bottom, but the result is that all the great heaps of mud, and sand, and pebbles, and angular stones, mixed up with the remains of animals and vegetables, become buried —carried down bodily away from the surface, and covered up with similar deposits.

Material thus depressed and squeezed, after being deposited in water, becomes exceedingly compact and tenacious, as is known by the state of the mud at the bottom of the Atlantic. Under such circumstances, it parts with some of the water with which it was formed, and it tends to become solid. It then by degrees enters into a region where the temperature is equable. As it goes deeper it is exposed to greater heat, and it is highly probable that the law of increase of temperature in descending into the earth, which is pretty uniform for 2000 feet, continues nearly the same to much greater depths. By degrees, then, the descending mass becomes heated, and at the same time it is constantly under pressure.

That the currents of electricity producing the phenomena of earth-magnetism chiefly act within a certain distance from

the external surface of the earth, that they permeate all matter placed there, and that in so doing they induce chemical action, are among the conclusions which the discoveries of modern science may be said to render certain. Thus the matter originally deposited as mud, and consisting of a heterogeneous assemblage of the minerals most common at the earth's surface, is now placed under the conditions known to be most favourable for enabling all its component parts to exercise their chemical affinities and re-arrange themselves in new forms.

The first result of this is that like things collect together. In a mixture consisting of clay and limestone mud, the limestone or calcareous part collects into bands of nodules at certain distances apart; the sulphur and iron, if present, combine to form pyrites; the excess of iron, if any, is converted into oxide, and combines with the calcareous nodules, forming poor or rich earthy iron ores, according to circumstances; and so on with other elements.

Meanwhile the whole mass, becoming systematically compacted, contracts, and crevices occur—thin, perhaps, and partial at first, but more or less open, and gradually increasing. Crystallization takes place in some of the minerals easily crystallizable, and that curious change takes place called by mineralogists *pseudomorphism*—the removal of some definite form, and the replacement of the original by some new substance. The remains of organic beings, animal and vegetable, become converted into fossils.

Throughout the whole mass, whatever else is going on, and in whatever state it may be, water is constantly circulating. Entering the earth at every pore, passing down through all rocks in all conditions, dissolving everything as it goes, leaving behind in every place something new, and modifying every form of matter, this great power, this really universal menstruum, knows no obstacle, and never ceases to do its work. Carried down at first through open fissures in all rocks, it is further conducted through the open and permeable sands in large quantities, and through rocks of closer texture, by the most minute capillary tubes. The actual quantity of water in all rocks varies from five to forty parts in a thousand, even when they are in the driest state to which they can be reduced by exposure to the air.

And here, again, we are able by actual experiment to understand something of nature's methods in the interior of the earth. It might well be supposed that rocks squeezed under enormous pressure would become more compact and less porous; on the contrary, they become more porous, and it is certain that both the dissolving and penetrating power of water are increased in proportion to the pressure. Thus the

work that goes on very slowly and imperceptibly at first, is more rapid and energetic in proportion as the depth is greater, and the most impracticable and refractory rocks are those which are more thoroughly influenced by the action of water in the interior of the earth.

That water is capable of reaching the separate minerals of crystalline rocks, acting specially on some one of them, removing one member of a group, and replacing minerals by others, without in the smallest degree altering or affecting the external form, is a fact of which there is absolute proof. That water alone is capable of replacing the limestone of a shell by galena and other sulphides of metals, and even by native metals, such as silver or copper, is equally certain. That water alone has dissolved and removed, in one case, silica; in another, carbonate of lime; in another, felspar, and probably almost every familiar mineral, placing in the stead of these other minerals, which it can also again remove, is one of those curious and almost inexplicable facts that nothing but absolute and direct proof could make credible; but facts are stubborn things, and must be accepted when they present themselves.

When, then, in crevices of rocks, whether wide or narrow, and whether filled completely or partially, we find groups of strange minerals and metals, quartz, and other crystals, and even granite and porphyry (mixed masses of crystals), we need not at once assume that these have been once in a molten state; we should rather inquire how far they may have been separated out from the mass, or introduced by currents of heated water acting during long periods of time under certain chemical conditions. Some of the appearances it is now certain may have been produced by water; most of them cannot be proved to be brought about by fusion under any known contingencies.

But if this is the case with veins, much more is it the case with the masses of rocks loaded with organic remains still retaining their intimate structure. In them there is often a wide departure from the normal condition of soft mud, sand, pebbles, and animal or vegetable remains; and yet, though so great a change has supervened, there has certainly been no exposure to heat, for none of the results of heat are in any way traceable. Where, as in the case of leaves and wood, heat would convert the whole mass into an ash, the result is the production of a combination of carbon, hydrogen, oxygen, and other gases, capable of serving still as an admirable fuel. It is not necessary to point out what the result would be if heat had been applied to such a combination; but where the case is less manifest, it is often not less certain, and thus abundant proof exists of the possibility of enormous and complete change without any exposure to burning heat. In all cases, however,

there is change, and generally it is of a very marked kind, between the original and present condition of rocks. This change is *metamorphism*.

Let us consider the principal varieties of rocks, one after another, with reference to this point. Sand and pebbles, with occasional thin beds of marl, are the rocks least altered, and often these are hardly changed from their original state. They are neither more compact nor of different texture. Sometimes, however, they are converted into stone, the sand particles being cemented by carbonate of lime, silica, or oxide of iron, all clearly and unmistakably brought in and deposited by water. Sometimes, parts are unchanged and other parts converted into crystalline quartz rock, with no mark of heat. Sometimes, on the marly films are crystals of marl, occupying places once occupied by crystals of salt. The marl has been carried in by water to replace the salt crystals dissolved by water. Scarcely any organic remains are preserved in such material now, and there is not much indication of life in the older example, but footprints of animals, worm casts, etc., prove that life was present. Crevices in the sand rock are filled up with crystalline quartz, certainly of water origin.

Limestones are more varied and richer. Deposited as mud, or coral, or shell sand, the particles are cemented by carbonate of lime. Sometimes the whole mass is compact and crystalline, sometimes parts are crystalline, sometimes the whole is semi-crystalline. The shells are changed; they preserve their form; they sometimes retain parts of their original structure, and sometimes they are full of calc spar; or the shells are gone, and their place is occupied by casts, also of carbonate of lime, or perhaps of iron oxide. The whole mass is uniformly tinted with iron oxide, or the iron is collected into belts, and these are often rich enough to be exceedingly valuable as iron ore. The rich ores recently discovered and now chiefly used in the north of England are of this kind. Any foreign substances once mixed up with the limestone mud are now collected and separated in veins or crevices. Large cavities and empty spaces are common in the mass, and these are filled partly with broken fragments of the same limestone, partly with valuable ores of lead and zinc. The whole series of operations, thus changing the limestone mud into important limestone rocks, with mineral veins, is the work of currents of water. Water has compacted the loose particles; water has opened large cavities; water has filled them with quartz and other crystals; and water has carried in the metals. A little heat would have changed the whole mass, and caused fresh combinations. This at least is the case as far as we can judge. It is the case according to experiment, and no one, without conflicting

proof from experiment, is justified in making a contrary assumption.

And the case of clays is not different. Very frequently retaining all their essential features as aqueous rocks:—the marks of bedding still easily seen:—the remains of plants, shells, teeth, and bones, still common:—it is not rare to find some of these clays converted into slates, and it is yet more usual to find them alternating with calcareous or irony bands, as already alluded to. These are not unusually collected round some group of fossils, acting perhaps as a disposing cause for the separation. The slates are yet more striking illustrations of change; and in them also occasionally shells and other fossils, little altered, indicate a water origin. Water currents, acting under enormous pressure, have so far altered clays that they have become slates. But the veins, or cracks and crevices that abound in slates, are filled with quartz in a crystalline state. These are often full of holes, and within them sometimes iron pyrites, sometimes valuable ores of copper, make their appearance. But in the deposits of ore there is still no appearance that is not more readily explained by the action of water than by fusion. Currents of heated water—electric currents passing through the earth in definite courses—these would seem to have been the agencies in producing all the transformation and metamorphosis of the richest metalliferous rocks of Cornwall and other countries where mining is carried on in slate.

When we examine such rocks as granite and the large group of compounds of which it is the type, we enter on more doubtful ground, and must therefore tread more cautiously. These have long been held as the proof of igneous action, and few are prepared on first examining them to attribute any of them to mere change in contact with water. But here again we are bound to look to the facts of the case—*esse quam videri* must be our motto.

And first there is the texture and appearance of granite itself as compared with rocks we know to have been molten, such as lavas, ancient or modern. Here the microscope comes into use, and teaches us that a very large class of rocks, of which granite is one, have, beyond all doubt, been formed in contact with water, for water in a fluid state is actually mixed up with them, and is contained within the separate crystals of which they are constructed. That granites, syenites, and greenstones, with the host of rocks of the same or nearly the same general character, which we may call porphyries for want of a better name, have been formed with water, there can indeed be no longer a doubt; but it is still uncertain what temperature has been needed to produce them.

That they have, however, in some cases, been produced by the change or metamorphism of regularly stratified rocks, and in the very midst of such rocks—some underlying them and some overlying—that certain parts of slates and such like rocks have been converted, or metamorphosed into granites, while other parts adjacent have not been more altered than slates generally are, is rendered so probable by the study of actual rocks in the field, that if not fully accepted as proved it must still be regarded as one of those matters to be expected, and of which there is every probability. There are now many places described in England, Wales, and Ireland where granites and porphyries of various kinds fairly alternate with slates and other rocks, where it is so utterly improbable that they can have been forced in between those rocks after being once formed, and so certain that they could not have been thrust in in a melted state, that we are forced to the conclusion above stated, namely, that granite also is metamorphic; that like the rest it is due to water rather than fire.

The reader may be prepared to ask how it is that chemical changes so energetic, transformations and replacements so complete, and metamorphoses on a scale so gigantic are consistent with the ordinary state of apparent tranquillity of the interior of the earth. The rumblings of earthquakes, though certainly not infrequent, are limited to very small area; the eruptions of volcanoes are very much more limited, and are altogether exceptional phenomena, occurring on a large scale only once or twice in a century. But the changes we speak of must be incessant, and their amount must be large. Their effects are everywhere.

We reply that the apparent repose of the earth is not real; that as the giant oak standing firmly rooted in the earth, and for centuries unmoved by the fiercest storm, owes its apparent uniformity of condition to changes incessantly going on within, and to ceaseless currents of sap that circulate through its whole tissue—that it only lives, and is strong, because of this continual change and replacement that we call life; so the great old globe itself has its life, its fluids circulating throughout, removing, replacing, modifying, and renewing. Everything in nature is in perpetual circulation, and water passing everywhere is the circulating medium. It is the earth's blood, preserving life, replacing the old and worn-out material by new material, separating that which has performed its work, and putting it in the way of entering into new combinations, and enabling it to come in once more as a useful element.

But there is something besides, for the word life has a different and a higher meaning. Vitality requires not only a circulating fluid, but a certain energy, which in the animal we

connect with the nervous system. Those currents of earth magnetism, obtained in some mysterious way from the sun, and passing from pole to pole of the earth, both above and within the surface:—recognized in the air by one kind of phenomena, and now well recognized in the substance of the earth by their effects on the telegraph wire:—those electric forces induced by and governing chemical change, such as the passage of currents of water through different minerals cannot fail to produce; all these are the representatives of nervous energy in the earth, while all, so far as we know, are strictly superficial phenomena. Lastly, there is vital heat, represented in the earth also by the higher and equable temperature at moderate depths.

These inquiries have nothing to do with doubtful questions as to the earth's nucleus and its temperature now, or at any previous period; they are fair questions for discussion, for they admit of experimental investigation, and they tend to place geological science on its right footing, apart from mere idle theory and baseless assumption. Thus we know that water can traverse all rocks, and we have the best possible reason for believing that it does so. We know that it is capable of dissolving almost every element, and that it acts energetically on most rocks when containing certain acids which are constantly provided. We know that earth-magnetism is a reality, and that magnetic and other forms of electricity are convertible; we can hardly doubt also that heat and electricity and chemical action are mutually convertible, and in the strictest sense are co-relative. We know that chemical action induced by the passage of water under certain circumstances must involve changes of temperature, and that the increment of temperature thus produced may be very great. There is really no need for the assumption of a central fire, even to account for the steady increase of temperature observed at increased depths. We have no right to introduce the *Deus ex machinâ* when the ordinary machinery is sufficient, and so long as we can explain metamorphism by methods of nature that we understand and can copy; so long, in a word, as water will serve our purpose, it is certainly not philosophical, nor is it altogether reasonable, to allow ourselves to be prejudiced by vague resemblances, which, when traced to their foundation, are found to be little more than analogies.

Metamorphism, then, is a great fact in nature. Every fragment of limestone, sandstone, and slate, or shale, that enters into the composition of the rocks of the earth, is more or less metamorphosed; every fossil that is found bedded in rocks is likewise changed, and shows metamorphism. It is not only the granites and other crystalline rocks that have been so much altered that their original texture and history are lost sight of;

but all other rocks in all countries tell the same tale. There are proofs of this, and illustrations of the mode of change everywhere, and the great agency employed has certainly, in most cases, been altogether unconnected with heat and igneous fusion. The very oldest rocks, even those lowest in the series, all speak by their nature, structure, and composition of other rocks still older, all, without exception of the stratified series, have been derived by the aid of water from the destruction of some of yet greater antiquity. And amongst rocks of all ages are the granites: in rocks of all ages are veins of greenstone and such like mineral compounds. Were all these thrust up in a melted state through the stratified rocks and amongst them, or have they not rather been deposited where we see them in a more quiet way by the help of water acting under favourable conditions of temperature and chemical force? These are important questions in modern geology. It is certain that granites and porphyries are not all of the same date, but that some have lasted little altered during whole geological periods, while others have been elaborated in recent times. But so it is also with slates, and schists, and limestones, for some of these are new and some old, although the appearances hardly vary. There is no great heat required for most of the changes, and, in fact, many of them are absolutely inconsistent with the presence of such an amount of heat as would produce fusion.

On the other hand water and its known action afford the only simple and intelligible explanation of a large class of phenomena, and will explain the universal difference traceable between recent deposits and those that have long been deposited, and have undergone change of position and exposure to the causes at work beneath the earth's surface. Water and fire are two important agents employed by nature, and both assist in the same great work—that of inducing chemical and atomic change. Both seem to produce, or at least to pave the way for decomposition and re-combination. Each is powerful, and opposite as they seem, both work together in the production of all great results in nature. Near the earth's surface, however, water acting at moderately high and equable temperatures, and under pressure, would seem to be nature's method of bringing about the largest results, and this seems to be not only the case at present, but to have been equally the case in the very earliest times which geological investigation introduces to our notice. The only clear and unmistakeable proofs of igneous action that we possess are the modern lavas, and those ancient sheets of lava called basalt, that have clearly been ejected in a molten state, and have spread themselves in thin sheets over the surface. These at all times seem to have been partial, and on a small scale, and would appear to have few if any relations

with the larger metamorphoses which we have been considering in the present article.

In conclusion, however, let the reader be advised, if not yet familiar with the practical work of geology, to accept no theory, and be bound by no respect for established authorities in this matter. Geology is a subject for study, and not for dogmatic statement. It is not desirable to raise another such storm as that which disturbed the serenity of the scientific horizon when the aqueous and igneous theories were first propounded. We need not shut our eyes to truth because it seems opposed to opinion, but we should observe closely and avoid coming to conclusions too rapidly. Metamorphism is a great and difficult subject.

ATMOLYSIS.

BY W. B. TEGETMEIER.

In the previous volumes of the Intellectual Observer* will be found notices of the discovery of the phenomena of Dialysis, by Mr. Graham, the Master of the Mint; of its application in the explanation of natural occurrences, such as the formation of minerals, and also of its practical utility when applied to the arts of life and civilization. Mr. Graham has been continuing these investigations with that profound originality of research that has caused him to be regarded by scientific men as one of the most illustrious investigators in the highest branches of physical science.

The phenomena attending the passage of liquids through thin membranes constitute what is termed dialysis. Those under consideration at present, depend on the passage of gases through porous plates.

Mr. Graham commenced this train of investigation many years since, and, from time to time, some of his results have been made known. The instrument originally employed in these researches was termed a diffusiometer, and consisted of a plain, cylindrical glass tube, one inch in diameter, by ten inches in length. This, by being closed at one end by a thin plug of plaster of Paris, was converted into a receiver capable of being used over mercury. At the present time, compressed graphite has been substituted for the plaster of Paris; this is obtained by cutting slices with a fine steel spring-saw off the compressed blocks used for the manufacture of pencils. These slices, by rubbing down on a dry sandstone, can be obtained

* Intellectual Observer, vol. i. pp. 156 and 381; vol. ii. p. 224.

of a degree of thickness not exceeding one-half a millimetre, about the thickness of an ordinary wafer: one of these plates attached by cement to the end of a glass tube closes it and forms a diffusiometer. During the process of filling over a mercurial trough, the porous plate is covered with a thin sheet of gutta-percha; on removing which, diffusion immediately takes place.

If one of these tubes be filled with hydrogen, it is found that the gas will totally diffuse itself into the air in the space of about forty minutes; about one-fourth as much air passing through in the reverse direction, and the mercury rising against the influence of gravity, to supply the space left by the more rapid diffusion of the hydrogen.

It is found that the pores of the compressed graphite are so minute, that the gas in a mass does not pass through, but that the molecules only pass by a sort of intestine motion. According to the hypothesis advanced to account for this circumstance, gases consist of perfectly elastic atoms which move amongst each other with different degrees of velocity in the different gases; and when the gas is confined in a close vessel, the atoms impinge against the sides and against each other, but that this occurs without any loss of velocity owing to their perfect elasticity.

If, however, the sides of the vessel are porous, the atoms moving against the open channels escape, and, in the same manner, the air or any gas which may be external to the vessel, enters. When the same gas is on both sides of a porous vessel, the interchange takes place, but it is not attended with any alteration of bulk of the contained gas. In the case of some gases which diffuse at the same rate, as for example, nitrogen and carbonic acid, the interchange takes place without any change of volume. But with gases having an unequal molecular velocity, as air and hydrogen, the diffusion is unequal.

The further investigations of Mr. Graham relate to the laws affecting the passage of a gas, either by pressure or by its own elastic force, through a graphite plate in one direction only, a vacuum being maintained on the other side. A gas may pass into a vacuum in three different modes:—

1. When a gas passes into a vacuum through a minute aperture, as a hole in a plate of platinum foil, its rate of passage is regulated by its specific gravity. "A gas," says Mr. Graham, "rushes into a vacuum with the velocity which a heavy body would acquire by falling from the height of an atmosphere composed of the gas in question, and supposed to be of a uniform density throughout. The height of the uniform atmosphere will be inversely as the specific gravity of

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the gas, the atmosphere of hydrogen being, for instance, sixteen times higher than that of oxygen; but as the velocity acquired by a heavy body falling is not as directly the height, but as the square root of the height, the rate of flow of different gases into a vacuum will be inversely as the square root of their densities. The velocity of oxygen being 1, that of hydrogen will be 4, the square root of 16. This law has been experimentally verified," and the mode of passage is termed *Effusion.*

2. If the aperture be in a plate of increased thickness, the law of effusion no longer holds good. When the length of the tube exceeds the diameter by 4000 times, a new ratio is established, that of the *Capillary Transpiration of Gases.* The rates of transpiration are not governed by specific gravity, and are singularly unlike those of effusion, the transpiration velocity of oxygen being 1, that of chlorine is 1·5, and that of hydrogen 2·26. These ratios appear in constant relation to no other known property of the gases, and they form a class of phenomena remarkably isolated. Exceedingly minute capillary tubes, however numerous, offer practically a perfect impediment to the passage of gas by transpiration.

3. The diffusive, or molecular movement of gases, enables them readily to pass through plates of graphite which are, practically, impenetrable to gas by either of the two preceding modes; this penetration appears to be due entirely to their own proper molecular motion, entirely unaided by transpiration, and uninfluenced by pressure. The graphite appears, as it were, to become a molecular sieve, allowing molecules only to pass through, and, consequently, hydrogen is found experimentally to pass through a graphite plate with precisely the same velocity, whether it is passing into a vacuum or into air.

These abstract investigations of Professor Graham have already been pressed into the service of practical science. An instrument termed an *Atmolyser* has been designed, by means of which mixed gases of different diffusibility can be separated. The most remarkable effects of separation are produced by the *tube atmolyser;* this is simply a narrow tube of unglazed earthenware, similar to a tobacco pipe stem, two feet in length, which is placed in a shorter tube of glass, and secured in its position by corks, so as to resemble in appearance a Liebig's condenser; the glass tube is then exhausted of air by being connected with an air-pump, and a mixed gas is allowed to flow through the earthenware tube, when the more diffusive gas is rapidly abstracted. Thus, when an explosive mixture of two volumes of hydrogen and one of oxygen is passed, the gas issuing from the tube consisted of oxygen, with less than 10 per cent. of hydrogen—a mixture which could not be ignited.

These considerations of these phenomena have led Mr. Graham into certain speculations respecting the constitution of matter. It is conceivable that the various kinds of matter, now regarded as different elementary substances, may possess one and the same ultimate molecules in different conditions of movement. The essential unity of matter is a hypothesis in harmony with the uniform action of gravity on all bodies; we may imagine one substance only to exist, namely, ponderable matter, and that this is divisible into ultimate atoms, uniform in size and weight; if these atoms were at rest the uniformity of matter would be perfect. But they always possess more or less motion due to some original primordial impulse; this motion gives rise to volume; the more rapid the motion the greater the space occupied by the atom. Thus, matter of different density forms different substances, that are usually regarded as different inconvertible elements, and this hypothesis may be pursued through the various phases of combination; the different states of solid, liquid, and gas, and the colloid and crystalline forms of matter.

Recent as are these discoveries and speculations of the author, they have already a practical bearing on the communication of heat to or from gas or vapours, by contact with solid or liquid surfaces; for the impact of the gaseous molecule on a surface possessing a different temperature from itself appears to be a condition of the transference of heat from one to the other. The more rapid the molecular movement of the gas, the more frequent the contact, and, consequently, the more rapid the communication of heat. Hence, the great cooling power of hydrogen as compared with that of air or oxygen. These gases have the same capacity for heat, as regards equal volumes; but a hot body placed in hydrogen is really touched 3·8 times more frequently than it would be if placed in air, and 4 times more frequently than it would be in an atmosphere of oxygen. This property of hydrogen recommends the application of that gas to the air or caloric engine, where the object is alternately to heat and cool a confined volume of gas with great rapidity.

There can be no doubt but that engines worked by steam, the employment of which is always attended with so great a loss of heat, will eventually be superseded by air or caloric engines, where there is no loss by condensation. Theoretically, air engines are perfect, and the practical difficulties that prevented their adoption are being gradually overcome.

THE TINNEVELLY PEARL BANKS.

BY CLEMENTS R. MARKHAM, F.S.A., F.R.G.S.

From time immemorial the pearl fishery in the narrow sea which separates India from the island of Ceylon has been famous in all the marts of the old world, and has rivalled the still more renowned fishery of Bahrein, in the Persian Gulf. Opinions have always varied respecting the value of the pearls from these fisheries. Tavernier, the old travelling jeweller, said, in 1651, that the pearls from the sea that washes the walls of Manaar, in Ceylon, are, for their roundness and water, the fairest that are found, but rarely weigh three or four carats. Master Ralph Fitch, a London merchant, who made a voyage to the Indies in 1583, says, on the other hand, that, though the pearls of Cape Comorin are very plentiful, they have not the right orient lustre that those of Bahrein have. Whatever the truth may be respecting the water and orient lustre of the pearls of these rival fisheries, there can be no doubt that a vast concourse of merchants and others has been annually attracted to the fisheries in the Gulf of Manaar from the most ancient times, which is sufficient evidence of their value.

The Ceylon fisheries have retained their old reputation down to modern times. But it is to the smaller and hitherto less productive pearl banks, on the opposite side of the Manaar gulf, off the shores of the Indian Collectorate of Tinnevelly, that the reader's attention is requested. An experiment, with a view to the improvement of the fishery, has now been commenced there, which possesses considerable scientific and general interest.

In the golden age of the Tamil people of Southern India, the Tinnevelly pearl fishery, then established, as Ptolemy states, at Kôru, the more modern Coil, paid tribute to the Pandyon kings of Madura; and at this period, we are told by the author of the Periplus of the Erythræan Sea, none but condemned criminals were employed in the fishery. Marco Polo, in the end of the thirteenth century, mentions the land of Maabar,* where many beautiful and great pearls are found off the coast. The merchants and divers, he says, congregated at Betaler, in April and May, and he relates how the divers, called *Abraiamain*, performed incantations to preserve themselves from the attacks of great fish in the depths of the sea.

* *Maabar* of Ibn Batuta and Marco Polo is the southern region of the Coromandel coast, comprised in the modern districts of Madura and Tinnevelly. Colonel Yule has suggested that the word may be Arabic (*Ma' abar*, a ferry), in reference to the passage or ferry to Ceylon.

In those days the sovereign received a tenth, and the divers a twentieth of the proceeds of the fishery. The great number of pearls from these Tinnevelly banks excited the wonder of all the bold wanderers who completed the perilous voyage to India in early times. Friar Jordanus, a quaint old missionary bishop, who was in India about 1330, says that 8000 boats were then engaged in this fishery and that of Ceylon, and that the quantity of pearls was astounding, and almost incredible. The head-quarters of the fishery was then, and indeed from the days of Ptolemy to the seventeenth century continued to be, at Chayl or Coil, literally "the temple," on the sandy promontory of Ramnad, which sends off a reef of rocks towards Ceylon, known as Adam's Bridge. Old Ludovico di Varthema mentions having seen the pearls fished for in the sea near the city of Chayl, in about 1500 A.D., and Barbosa, who travelled about the same time, says that the people of Chayl are expert jewellers who trade in pearls. This place is, as Dr. Vincent has clearly shown, the Kôru of Ptolemy, the Kolkhi of the author of the Periplus, the Koil or Chayl of the travellers of the middle ages, the Ramana-Koil (temple of Rama) of the natives, the same as the sacred promontory of Ramnad and isle of Rameswaram, the head-quarters of the Indian pearl fishery from time immemorial.

But Tuticorin, the present head-quarters of the fishery, has supplanted the ancient Coil for the last two centuries; and, since the middle of the seventeenth century, the powers which have successively presided over the fishery, whether native, Portuguese, Dutch, or English, have uniformly taken their station at this little port, which is about ninety miles north-east of Cape Comorin, on the Tinnevelly coast. When the Portuguese were all powerful on the coast, the Jesuits were allowed the proceeds of one day's fishing, and the owners of the boats had one draught every fishing day. The Naik of Madura, the sovereign whose family succeeded the ancient Pandyon dynasty, also had the proceeds of one day as Lord of the coast. These Naiks were the builders of all the magnificent edifices which now beautify the city of Madura, and their dues from the fishery were probably used as offerings to Minakshi, the fish-eyed goddess of the vast Madura pagoda, who now possesses, amongst her jewellery, a numerous collection of exquisitely beautiful pearl ornaments. In the days of the Naiks and Portuguese there were 400 or 500 vessels at the annual fishery, carrying sixty to ninety men each, a third of whom were divers; and at the subsequent fair held at Tuticorin there was an assembly of from 50,000 to 60,000 persons. The divers, at that time, were chiefly Christians from Malabar. Captain Hamilton, who was travelling in the East from 1688 to 1723,

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described Tuticorin when the Dutch were all powerful at that port, as well as in Ceylon. He says that a Dutch colony at Tuticorin superintended a pearl fishery a little to the northward of the port, which brought the Dutch company £20,000 yearly tribute.

The Dutch appear to have fished too recklessly and too often; and, when the English succeeded them at Tuticorin, the banks were very far from yielding £20,000 a year. Our predecessors had well nigh killed the goose with the golden egg; and for many years we followed in the same track. It is the old story: a valuable product is discovered to be a source of considerable wealth, and forthwith a system of reckless destruction for the sake of immediate gain is inaugurated. Then the supply begins to fail—a panic ensues; and, when science and forethought are called in, it is discovered that ordinary prudence and a judicious system of conservancy would have ensured an annual unfailing yield from the first. Such has been the history of Chinchona bark in South America, of the teak and other timber of the Indian forests, and such also is the story of the Tinnevelly pearl banks since the Dutch times.

In 1822 the Tuticorin pearl fishery contributed about £13,000 to the Indian revenue, and in 1830 about £10,000; but after the latter date there was no yield at all for many years. Between 1830 and 1856 there were thirteen examinations of the banks, and on each occasion it was found that there was not a sufficient number of grown oysters to yield a profitable fishery, and none was therefore attempted. The unsatisfactory condition of the banks was attributed to several causes. Captain Robertson, the Master Attendant at Tuticorin, thought that the widening of the Paumben channel, which caused a stronger flow of current over the banks on the coast, prevented the molluscs from adhering; and that the fishers for large conch shells called *chanks* (which are used as horns in the worship of idols, and cut into segments of circles as ornaments for women's wrists), anchoring their boats on the banks, killed the oysters. The dead oysters would, of course, have a fatal effect on their neighbours. The native divers attributed the state of the banks to the pernicious influence of two other shell-fish, called *soorum* (a kind of Modiola) and *kullikoz* (an Avicula), which are mingled with the pearl oysters on the banks, and, as the natives believe, destroy them.

In 1856, however, an examination was made by Captain Robertson, and it was found that at least four of the banks off Tuticorin, called *Cooroochan Paur, Navary Paur, Oodooroovie Paur,* and *Clothie Paur* were well covered with young pearl oysters, which would be old enough to be fished in 1860-61. The Madras government, therefore, determined that every pre-

caution should be taken, in order that the banks might receive no injury during the interval. The chank fishery off Tuticorin was ordered to be entirely put a stop to at the termination of the contract, and vessels were provided to protect the pearl banks from poachers, on board one of which Captain Robertson was unfortunately lost in March, 1859.

Captain Robertson was succeeded as Master Attendant of Tuticorin and Superintendent of the Tinnevelly Pearl Banks by Captain Phipps, to whose zeal and intelligence the fishery owes its present hopeful condition, and under whose auspices the fishery of March, 1860, the first that had been attempted since 1830, was opened.

A Government pearl fishery is a most legitimate source of revenue, and forms an exception to all other monopolies; which, as a rule, have in modern times been justly condemned. But pearls are simply articles of luxury in the strictest meaning of the word; the seas in which they grow cannot well become private property; and, if a profit can be derived from their sale, it is certainly a branch of revenue which can give just cause of complaint to no man, while it benefits the community at large. In India, too, the Government are possessed of advantages which enable them to get the work of superintendence and management done with far greater economy and efficiency than could be secured by any private individual or company. So high an authority as Mr. McCulloch has taken an opposite view, and says that the Government monopoly ought to be abolished, because the expense of guarding and managing the banks exceeds the sum for which the fishery is let, and that any one who likes should be allowed to fish on paying a moderate license duty. The last edition of the *Commercial Dictionary* was published in 1860, and during the two following years the Tinnevelly pearl fishery yielded a large nett revenue to the Government, which is a sufficient answer to Mr. McCulloch's argument. It is true that there has since been disappointment; but the way to secure regular annual returns is by adopting a carefully considered scientific system of conservancy, and not by throwing the banks open to the depredations of all comers.

The fishery of 1861 commenced on March 7th, and the sale of the Government share of oysters was conducted by public auction, which began at Rs. 15, and gradually rose to Rs. 40 per 1000. As many as 15,874,500 shells were sold, realizing upwards of £20,000, as the nett result to Government, exclusive of all expenses, and of the shares allowed to the divers. The annual expense of the guard boats for protecting the banks is only £500.

In 1862 the results of the fishery were also satisfactory;

but in 1863 the banks were found to be in a most unpromising state, and no fishery was attempted. Out of seventy-two banks that were examined, only four contained oysters free from *soorum*, eleven had young oysters mixed with *soorum*, and fifty-seven were blank. It is this unexpected failure of properly-grown shells which has given rise to Captain Phipps' experimental culture now in course of trial, and to a very careful consideration of the conditions most likely to secure a good annual fishery, which shall not be liable to this periodical sterility.

The pearl banks are about nine miles from the shore, and 8 to 10 fathoms from the surface, being scattered over an area 70 miles in length. They are exposed to ocean currents, which, by washing sand into the interstices of the rocks, often destroy the young oysters over a considerable area; the dead fish, when not removed, soon contaminate their neighbours; and, in addition to these sources of evil, the *soorum* shells, a species of Modiola, like a mussel with a swollen face, which often grow amongst the pearl oysters, exercise a pernicious influence, either by dying and spreading death around them, or by accumulating sand. It is obviously quite impossible to watch these banks efficiently, and to eradicate the evils caused by sand accumulations and dead molluscs, owing to their great depth and exposed situation in the open sea at a distance from land. Unless some plan is adopted for rearing the young fish on banks which shall be constantly accessible, and free from the above drawbacks, the fishery will always be liable to failures, sometimes of long duration. The perfection to which science and intelligent care have brought the fisheries of edible oysters on the English, and especially on the French coasts, leaves no doubt that equally satisfactory results might be obtained from similar measures on the Tinnevelly pearl banks.

A few remarks on the habits of the pearl oyster will make this part of the subject more clear.

It is, perhaps, unnecessary to observe that the pearl oyster (*Meleagrina margaritifera*, Lam.) is not in reality an oyster at all, but is more allied to a mussel; having, like the latter animal, a *byssus*, or cable, by which it secures itself to the rocks—one of the most important points in its organization. The animal's foot is composed of muscular fibres, and is $2\frac{1}{2}$ inches long, when distended. On the lower side there is a groove lined by a secreting membrane, which is an exact mould for the formation of the *byssus*. When the animal desires to attach itself to the rock, its foot is protruded, and, after seeking out a suitable spot with the tip for some minutes, is again retracted into the shell. A strong fibre, of the form

of the groove in the foot, is thus left, attached to the base of the foot at one end, and to the rock at the other. The process is again and again repeated until a strong cable is formed; and it was one of the most important results of the careful investigations of Dr. Kelaart in Ceylon, that the power of the animal to cast off its *byssus* at pleasure was ascertained. It leaves it behind to make another in a more convenient place, like a ship slipping her cable and going to sea. From this ability to shift its berth it follows that the pearl oyster might safely be taken from its native beds, and made to colonize other parts of the sea; and also that it would move of its own accord if the surrounding water should become impure or sandy, or when there is an influx of fresh water. The animal can re-form the *byssus* at pleasure, if in good health and condition.

The formation of pearls is another point which has received much attention, but which has not as yet been definitively settled. Pliny and Dioscorides believed that pearls were productions of dew, but that observant old Elizabethan navigator, Sir Richard Hawkins, shrewdly remarked that "this must be some old philosopher's conceit, for it cannot be made probable how the dew should come into the oyster." Modern investigation has suggested various causes for the intrusion of the nucleus round which the pearl is formed. The free border of mantle lining each valve of the shell dips downwards to meet a similar edge on the opposite side, thus forming a double fringed veil. The tentacles of this fringe consist of long and short flat filaments, which are exceedingly sensitive, so that even the approach of a foreign substance makes them draw forwards and shut out the intruder. They doubtless prevent the pearls from dropping out of the shell, and preserve the fish from the host of carnivorous creatures which infest its place of abode; and if it be true that particles of sand form the nuclei of pearls, they must run the gauntlet of these ever-watchful sentinels before they can intrude themselves amongst the interstices of the mantle. The food of pearl oysters consists of foraminifera, minute algæ, and diatoms; and Dr. Kelaart has suggested that the siliceous internal skeletons of these microscopic diatoms may possibly permeate the coats of the mantle, and become nuclei of pearls.

Lastly, the *ova* which escape through the distended coat of an overgrown *ovarium* may, perhaps, become embedded in the interstices of the mantle, and become the nuclei of pearls, especially as pearls are usually found embedded in the mantle near the hinge, where the *ovarium* is most liable to rupture. Large pearls often work their way out of the mantle, and lie loose between it and the shell, or become attached to the surface of the latter. They have even been found outside

the shell altogether, entangled amongst the strands of the *byssus*. When the pearl banks are under constant supervision, the causes leading to the formation of pearls, as yet imperfectly understood, will, doubtless, receive close attention.

It now only remains to describe the plan by which it is hoped that, in future, the Tinnevelly pearl banks will be kept supplied with a sufficient number of well-grown shells to supply a remunerative annual fishery. The idea was suggested by the method adopted with regard to edible oysters on the English and French coasts. The chief external difference between the pearl and edible oyster is, that the former secures itself to rocks and stones by means of a *byssus*, while the latter merely lies flat on the ground on its convex side; but there is no reason why the pearl oyster should not thrive on artificial banks as well as the edible oyster.

In the Colne oyster fishery, the *brood* (oysters two years old) are dredged up out at sea, and placed on "*layings*" within the river Colne. These "*layings*" are about 100 or 150 yards by 80, according to the breadth of the channel, most of them dry at low water, and they are paved with stones, old shells, and any other hard substances, to a depth of a few inches, so as to form a bed for the oysters, which would be choked in soft mud. This material is called *culch*. In France, M. Coste has adopted a system of placing fascines on the *layings*, instead of *culch*, as resting places for the oysters; but the natural advantages of the ground render any artificial method of this kind unnecessary in the Colne. It is very important that the *culch* should be kept perfectly clean and clear of mud, and, above all, that every mussel-shell should be weeded out. The mussels have a remarkable tendency to collect mud round them in heaps, probably owing to their elongated shape, and if they are allowed to remain on the *layings*, there is danger of the oysters being choked with mud. The oysters remain on the *layings* for two years, when they are fit for eating, and during this time there are constant examinations, in order that all dead fish may be removed, and the *culch* kept clear of mud. In places where the layings are never laid bare by the tide, this is done by means of a dredge, all live fish and *culch* being carefully thrown back, while dead fish, soft mud, and mussels are removed.

There can be little doubt that some such system might be adopted in rearing pearl oysters, and Dr. Kelaart says that "he sees no reason why pearl oysters should not live and breed in artificial beds, like the edible oysters, and yield a large revenue." He has ascertained, by his experiments in Ceylon, that the pearl oysters are more tenacious of life than any other bivalve with which he is acquainted, and that they can live in brackish

water, and in places so shallow that they must be exposed for two or three hours daily to the sun and other atmospheric influences. Captain Phipps, the superintendent of the Tinnevelly pearl banks, has come to the same conclusions; and, convinced that artificial nurseries for the young oysters are the only means by which remunerative fisheries can be ensured, he has proposed the following plan, which has been adopted:—

The harbour of Tuticorin is formed by two long islands, and between them and the mainland there is a bank about three miles long by a quarter of a mile broad, with a depth of from three to seven feet, entirely free both from surf, currents, and influxes of fresh water. Captain Phipps proposes that this bank should be walled round with loose coral until it is formed into a basin, the edges rising three feet above high water mark. Over the bed of the shallow basin thus enclosed, live coral will be regularly spread, so as in a few years to form a solid mass, serving the purpose of *culch*, and the basin will be divided into three parts, one for the old oysters, and the other two for the young ones that may be in process of rearing. After the division of the basin set apart for breeding has been stocked, it will be carefully watched, and when the spawning has taken place and the young oysters are well formed, they will be removed from the old oysters and rocks to which they are attached, and placed in one of the separate parts of the basin, and the same plan will be followed each succeeding year. On reaching a sufficient age, they will again be removed to one of the pearl banks in the open sea. The last operation is necessary, because it would be impossible to enclose an artificial space which would hold as many grown oysters as are required for a remunerative fishery, and because it is believed that the quality of the pearl depends on the depth and clearness of the sea in which it has been formed.

A single oyster, five or six years old, often contains no less than 12,000,000 eggs, and in the fishery of 1861 the total number taken only amounted to 15,874,500, so that the number of young ones annually obtained from the nursery will be abundantly sufficient to stock banks for each year's fishery. Care will of course be taken that only such banks are selected for stocking as have the rocks which compose them raised well clear of the surrounding sand.

By this system, adapted as it is from those of the English and French edible oyster fisheries, several advantages will be secured, and all the dangers to which the pearl oysters are now exposed will be avoided. The young growing molluscs, safe on their carefully watched *laying* at Tuticorin, will be secured from the choking sands of their natural banks, as well as from their alleged enemy, the *soorum*, the effects of which

are probably the same as those caused by the mussels on the edible oyster *layings* in the Colne. It is during the period of their growth that the pearl oysters are so exposed to these dangers, and very frequently banks have been found well stocked with young oysters, and giving promise of a lucrative fishery, at a preliminary examination, which, when the time for the fishery arrives, are bare, all their inhabitants having died and been washed away. But if preserved during the period of growth in the artificial nursery, and only placed out when they have reached maturity, the oysters can then form their pearls in security until the season for the fishery arrives, and well stocked pearl banks may be reckoned upon for each year.

Thus it is hoped that, by adopting these carefully considered plans, and improving upon them as experience and watchful investigation dictate from year to year, a regular and unfailing source of revenue will be secured to the State, and the Tinnevelly pearl banks will, after laying dormant for thirty years, regain the immemorial renown which was conceded to them, alike in the days of Ptolemy, of Marco Polo, and of Hamilton. They form the most ancient fishery in the world, and, now that science and careful supervision have been supplied, they will no longer be the least remunerative.

MICROSCOPE TEACHINGS.*

It is very easy to write a popular twaddle about science, but rare is the talent by which science is really popularized. For the first and useless performance, very slender knowledge is required, but the last requires both accuracy and depth. It also demands the enviable faculty of reducing a subject to its simplest elements, and presenting them in a pictorial and suggestive form. It is not enough to narrate facts, for unless they are judiciously expounded they remain in the mind as so many dead seeds destitute of germinating power. We often see this in pupils who have been well crammed by Mr. Feeder, B.A., or by his feminine counterpart, who is stuffed with Magnall's questions, impregnated with latitudes, carries dates on her fingers' ends, and diffuses an odour of the rule of three. The more people are taught after this fashion, the greater nuisance

* *Microscope Teachings:* Description of various Objects of especial Interest and Beauty adapted for Microscopic Investigation, illustrated by the author's original Drawings, with Directions for the Management of a Microscope, and the Collection and Mounting of Objects. By the Hon. Mrs. Ward, author of *Telescope Teachings.* London: *Groombridge and Sons.*

they are to their neighbours, and the less serviceable their minds become to themselves. They do not, properly speaking, *know* anything, because reflection has never been cultivated, and their imaginations have grown dull under a cumbrous load of ill-assorted materials. Widely different is the result of real teaching, whether its lessons are communicated orally, or reach the student through the medium of books. This is always conducive to mental growth and health, whatever form it takes, but perhaps never more so than when it charms the eye and the fancy with scenes of beauty from the world of nature, and extracts its lessons of wisdom from objects that gleam upon us from the heavens, or surround us on the earth. The advanced students of nature, if fitted for their work, are in the position depicted by Wordsworth in his *Prelude*. Without wrongful egotism they may exclaim,

> "What we have loved
> Others will love, and we will teach them how;"

and it is indeed a noble task to be the pioneers and guides into regions of truth and loveliness, infinite in their variety, perennial in their charm.

To the Hon. Mrs. Ward must be assigned an excellent place among these pioneers and guides. In her *Telescope Teachings* she has provided an admirable beginning for astronomical study, and her work on the microscope is by far the best that has been produced for the particular object its author had in view. It is, as befits an introduction to a delightful branch of practical science, an elegant book, enjoying all the advantages of excellent paper, large type, beautiful coloured plates, and handsome binding. The moment it makes its appearance in a civilized family there will be a rush towards it, and it will seldom fail to convert its readers into microscopists if they can obtain an instrument to work with as it directs.

Microscope Teachings is divided into twelve chapters, the two first giving very clear and useful information on microscopes, and the various processes and precautions necessary for their use. This will prove valuable to many purchasers of instruments, who often experience bitter disappointment after the optician has sent their instrument home, because no one is at hand to explain the details of manipulation, without which nothing but failure can arise. With Mrs. Ward's book they would make no mistakes, and her advice would guide them wisely in the selection of an instrument according to the expenditure they wished to make. Beginners should not be caught by the glittering appearance of a new microscope, and the number of articles supplied for a given sum. What they want is "that the microscope shows objects clearly, and is perfectly

achromatic, that is, without those fringes of rainbow colours always seen surrounding objects in inferior microscopes. It should also be constructed to lean backward, as being far less fatiguing to the observer than the upright position. It should have at least *two* different degrees of magnifying, and one of them should be of low power, with large field of view, for the purpose of showing as much as possible of an object at once. These, with the condensing lens, and mirror to throw light on or through objects, are things indispensable." A reference to our advertising pages will show how cheaply these necessaries can be obtained, and although those who have money to spare will be sure to want a superior instrument if they continue the pursuit, a comparatively simple one, judiciously selected, will serve all ordinary purposes of investigation or display. After giving information and advice, which every beginner will be glad of in learning to use a microscope, Mrs. Ward describes the methods of collecting and mounting objects, and then, in the fourth chapter, begins her list of objects with the structure of insects' wings. This chapter is illustrated by many, exquisitely-drawn, and coloured, figures from her own pencil, and is appropriately followed by another chapter on "the scales of insects and fish," which likewise supply beautiful plates. The objects described in these and other chapters are for the most part easily obtainable, and this is important, because, although it is both useful and pleasant to have a collection of slides prepared by professional mounters, the most substantial knowledge will be gained by collecting and mounting for ourselves. Every one ought to do this to a certain extent with reference to every class of object, even if the cost of prepared slides is of no importance; and those which are bought or given will be much better understood if the student has prepared something of the same kind for himself.

As a specimen of Mrs. Ward's directions we will cite her account of how to obtain the scales of the eel—a beautiful structure, which few who are in the habit of eating the creature take the trouble to behold. Our author says, "When I first began to prepare objects for the microscope, I read in some old book that these were worth looking at, so I procured a dry piece of eel skin, but it was long before I could find what I was in search of. I scraped and scraped with a knife, and examined the scrapings with a microscope, magnifying them twenty times—forty times—perhaps 100; but no scales appeared. I forget how I contrived to make them out at last; but, if I take a little piece of eel skin, and view it as a transparent object, magnified rather more than four diameters, the first thing I see is that the skin is covered with star-like spots, and next I observe the scales lying close together. And this is the way to

get at them: I take the little scrap of skin and tear it in two, exactly as if I were splitting a card, for the skin consists of two layers. I can easily lift them off with a knife and mount them for the microscope, while the skin makes another very pretty object for it, not unlike the spotted coat of a leopard."

Mrs. Ward's sixth chapter is devoted to hair and feathers; and, like the preceding, is beautifully illustrated; the seventh, relating to "eyes and other objects," also furnishes materials for an instructive plate, and shows how the optical apparatus of fishes, insects, and other accessible creatures, must be treated in order to display their elaborate provisions and adaptations to the conditions under which their owners live. The eighth chapter treats of "vegetable productions," the ninth of "organic remains, crystals, and artificial objects; the tenth and eleventh discourses of animalcules, and the twelfth concludes the work with an excellent little essay on "the circulation of the blood," and the various ways in which it may be pleasantly observed without injury or pain to the animal employed. The phenomena of circulation may be well shown in the young water newt, easily obtained from ponds in the spring. Mrs. Ward observes concerning it:—"The young smooth newt retains its external branchiæ to a much later period than is the case with the frog tadpole; although it would seem, from what I have observed, and also from Professor Bell's remarks on this subject, that there is a great variety in the period at which the branchiæ disappear in this species. I have, however, constantly met these young newts, when nearly two inches in length, still possessing those beautiful appendages; which, instead of being pale as at first, appear of a fine chestnut colour; but they have lost much of their transparency, and therefore for microscopic observation the newts answer best when of the size represented in the figure, and till they have grown to about twice that length. The great size of the corpuscles, as compared with the size of the animal, makes the object exceedingly striking. They are oval, like those of the frog, but larger, being (in round numbers) one eight-hundredth of an inch in length, while those of the frog are one eleven-hundredth; and both these are singularly large compared with those of man; these latter are but one three thousand two-hundredths of an inch in diameter."

Mrs. Ward also states that little newts are more tractable than frog tadpoles, and consequently easier to see; she likewise recounts how she once noticed the appearance of "a pink spot, apparently fading and re-appearing a number of times in a minute." This was the little creature's heart propelling its infant stream.

The specimens we have given will show the clearness of

Mrs. Ward's explanations, and the freshness imparted to her pages by their recounting genuine personal experiences—instead of the matter being, as is too often the case, borrowed at second-hand—will commend her work to every one into whose hands it may fall. The coloured plates, sixteen in number, are very artistic productions, and Mrs. Ward's labours, both with pencil and pen, will serve to encourage other ladies to a similar exercise of skill. Even where there is no idea of publication, a diary or journal should be kept of microscopic studies, and there are few families in which one or more of the number could not soon learn to draw well enough to illustrate it with effect. Work of various kinds necessarily occupies a large portion of the time of most members of society; but there is a great want of intelligent occupations, carried on with sufficient perseverance to become sources of permanent pleasure, and to have a wholesome influence on the mind. Microscopic pursuits can be so indefinitely varied as to suit a great variety of tastes; and, when a suitable instrument has been obtained, they involve little further cost. They should, therefore, be strongly encouraged, and it will not be found that, by so doing, anything like one-sidedness is created. On the contrary, different persons will take different fields, and all will find that a wide range of reading will be stimulated by the desire that must arise to gain information concerning the objects that are surveyed. Mrs. Ward's work will make its way into numberless homes, and all the more readily from its being an elegant present, for a sensible mother, or a convenient uncle, to give, and it may be read with the agreeable conviction that, though it is simple in form, it is strictly scientific in thought; and, by the fascination of its lucid style, it will induce many to become diligent students who would have been scared from the path of knowledge by a less accomplished and genial guide.

VANADIC ACID.

BY DR. PHIPSON, F.C.S., LONDON,

Late of the University of Bruxelles; Member of the Chemical Society of Paris, etc., etc.

It is now nearly sixty-three years since the observing world began to get glimpses of the metal Vanadium. In 1801, the mineralogist Del Rio, travelling in Mexico, met with a peculiar mineral in the lead mine of Zimapan, and announced that he had found in it a new metal, to which he proposed to give the name of *Erythronium*. This mineral, which, let it be stated immediately, was vanadate of lead (vanadinite), has been since met with in Dumfriesshire, at Wanlockhead, where it occurs as small globular masses, more or less crystalline, or as a thin coating, on Calamine; and also at Beresof, in the Urals, where it accompanies the mineral Pyromorphite. The Mexican specimens were reddish or yellow coloured, heavy, brittle, and fusible.

Del Rio analyzed this mineral, and assured himself that it contained an element then completely unknown. He sent specimens of it to Paris, where they were again analyzed by Collet Descotils, who declared that the new metal Erythronium was simply impure chrome, and, strange to relate, Del Rio adopted this opinion, and looked upon the newly-discovered mineral as a subchromate of lead.

It was not until twenty-nine years later, that Sefström of Stockholm discovered (1830) a new substance in Swedish iron, obtained from the iron ore of Taberg, not very far from Jungköping. This substance proved to be a metal, to which he gave the name of *Vanadium* (from Vanadis, a Scandinavian divinity, nearly forgotten by the northern poets of the present day). A little later, Professor Wöhler, of Gottingen, on examining specimens of Del Rio's mineral from Zimapan, found that it really contained, not chrome, but vanadium—that it was, in fact, vanadate of lead, and that Del Rio's first opinion, that it contained a new substance, was perfectly exact.

Not only the Swedish iron contained vanadium, but the iron slags or cinders, and the iron ore itself, were found to contain small quantities of *Vanadic acid* (the oxide or rust of the new metal). Berzélius and Sefström were the first to investigate thoroughly the properties of this curiously discovered substance. The metal is best extracted by passing a current of ammonia over chloride of vanadium heated in a glass bulb. It is a white metal, and, when polished, resembles silver. It

is not very ductile or malleable, and can be easily reduced to powder, like antimony, but is extremely difficult to melt.

This metal has not yet been applied to any useful purpose in the arts, but it is probable, or, rather, almost certain, that very small quantities of it in iron or other metals and alloys have a considerable influence upon their qualities. Three or four oxides of vanadium are known to exist, at least as laboratory products; one of them, vanadic acid, which will alone occupy our attention here, is the state in which vanadium has hitherto been found in nature. It is generally obtained as a pale-chocolate-coloured powder, almost completely insoluble in water, but soluble in alkalies, and fusible over a spirit-lamp. It shows a beautiful phenomenon whilst cooling, to which I have alluded in my work on Phosphorescence; when melted in a platinum crucible and allowed to cool slowly, it crystallizes, and emits at the same time a reddish phosphorescent light, during the whole time that the crystallization lasts. Several other mineral substances, and boracic acid in particular, exhibit the same curious emission of light when placed in similar circumstances.

Another remarkable property of vanadic acid, which leads us to imagine that this substance (so rare at the present day that scarcely any laboratory in London possesses a specimen) will be, some day or other, employed in the porcelain manufactories, is this: that when heated at the inner flame of the blow-pipe with borax, or with the double phosphate of soda and ammonia, it forms a beautiful green bead, a brilliant apple green, which it would be desirable to see produced upon porcelain.

The metal vanadium has been very little investigated, because the sources of vanadic acid have been found hitherto to be so extremely limited. Even the vanadate of lead discovered by Del Rio, which contains about 23 per cent., and similar minerals from Rhenish Bavaria and South America, giving 46 to 49 per cent. of vanadic acid (the Scotch specimens give 15 to 23 per cent.), are very rare; and the same remark applies to a vanadate of copper found occasionally in Transylvania and Thuringia, which contains 36 to 39 per cent. of the substance in question.

Vanadic acid has, however, been met with as an accidental constituent of several mineral substances, more or less plentiful, particularly in hydrated oxides of iron, in pitchblend (oxide of uranium), etc. We shall see, presently, the names of all those substances from which it has, up to the present day, been extracted.

In 1859, a young French chemist, M. Beauvallet, announced the existence of small quantities of vanadic acid in the clay

of Gentilly, near Paris, which is used to make the flower-pots for the Jardin des Plantes. It was in that year that Professor Pisani and myself procured some of these flower-pots, ground them down to a coarse powder, and extracted vanadic acid from them, but in very small quantities, for the process by which we operated (that recommended by Beauvallet) proved rather unsatisfactory. A little later, I submitted to the same investigation, in Pisani's laboratory, a variety of Belgian clays, from the neighbourhood of Ypres, Ostend, Lacken, etc.; and in 1860 and 1861, I made several new experiments on the extraction of vanadic acid from these substances, in my own laboratory in London. I examined particularly London clay and the gault of Sussex, also a peculiar hydrated oxide of iron from Saxony, which gave nearly two per cent. of vanadic acid, and some English iron-stones; and in 1863 I published in the *Journal of the Chemical Society* a short account of these researches. It was not known until then in what state vanadic acid exists in these iron-stones, clays, etc., but my analyses show that it is found as phosphate of vanadic acid, a compound described by Berzélius, and that the iron ores which contain much phosphoric acid are also those which yield most vanadic acid.

As the results of these analyses, I found that London clay contains from 0·023 to 0·056 per cent. of vanadic acid; the gault of Sussex yielded me 0·046 to 0·070 per cent.; the white clay of Ypres, in Belgium, 0·033 per cent.; an English iron ore (red hematite), containing much phosphoric acid, gave me as much as 0·40, and another 0·92 per cent. of vanadic acid. But the largest quantity was found in the iron-stone, which I have termed *vanadium ochre*, from Saxony, from which I extracted 1·60 to 1·90 per cent. In several other specimens of clays and iron-stone the presence of vanadium was put in evidence, but its quantity was not determined.

Other chemists have sought for vanadic acid in several mineral substances. A. Müller found 0·03 per cent. in an hydrated oxide of iron from Wittemburg; Fritsche found the enormous quantity of 1·78 per cent. in a German copper ore (Konichalcite), which doubtless contained some vanadate of copper, as well as arseniate and phosphate of copper detected by the author; Weibye found 0·22 per cent. of vanadic acid in a Norwegian schist (silicate of alumina), and Schrötter detected 0·37 per cent. in the iron slags of Verdenberg; whilst Kersten found 0·15 per cent. in some sulphide of iron slags, a small quantity also in the copper schist of Mansfeld; and H. Deville extracted as much as 0·32 per cent. from a specimen of rutile. Wöhler, Swanberg, and Ficinus have detected notable quantities of vanadic acid in the pitchblend of Germany and

Bavaria, but have not ascertained how much this mineral generally contains; neither did Sefström nor Schultz and Bodeman determine the quantity of vanadium present in the iron ores which they investigated. Deville likewise detected the presence of vanadic acid in bauxite, an aluminiferous mineral, from Baux, in the south of France, utilised in the manufacture of aluminium. The quantity of vanadic acid present in the flower-pots of the Jardin des Plantes was not determined. To allude to some substances which usually accompany vanadic acid in clays, I will mention that titanic acid and tantalic have been both found by myself and other chemists; also phosphoric acid is very usually present in small quantities.

One hundred parts of vanadium ochre gave me on analysis: water and a little organic matter, 12·60; oxide of iron, 57·50; alumina, 5·00; vanadic acid, 1·90; phosphoric acid, 2·20; titanic acid, traces; magnesia, 0·30; lime, 0·20; carbonic acid, 0·24; silica or quartz, 20·00 = 99·94.

Let us take 0·05 per cent. as the probable quantity of vanadic acid contained in the greater bulk of that vast geological deposit known as the London clay. At this rate one ton of London clay would contain about 1 lb. 2 oz. of vanadic acid, say 1 lb. to the ton in round numbers. If we suppose that there exists only about a million tons of this clay at the west end of London, for instance, in the Hyde Park and Bayswater districts alone, we have evidently there upwards of 445 tons of vanadic acid!

And if we calculate the quantity of vanadic acid which exists in the London clay of the metropolis, supposing London to cover fifty square miles, and taking the stratum of clay at the moderate thickness of four yards, we find that, under this city alone there lies probably far more than 303,443 tons, or about 679,712,320 lbs. weight of vanadic acid; the present price of this substance in shops where chemical curiosities are sold being about one shilling and sixpence per *grain*, or £32 5*s.* 6*d.* an ounce!

I have not the slightest doubt that all clays contain similar quantities of vanadic acid, and if it can be extracted with tolerable ease, both this substance and the metal it contains may sooner or later prove themselves new industrial agents in the hands of man. It remains only to discuss the most advantageous method of extracting vanadic acid, and it will be seen that the operation may be reduced to a very simple process:—

M. Beauvallet, M. Pisani, and myself began by boiling the baked clay of the flower-pots with three per cent. of its weight of carbonate of soda and a sufficient quantity of water. Finding that caustic soda, as recommended by H. Deville, appeared to answer better, I repeated the experiments with it in place of

the carbonate. The boiling must be continued for several hours, and even then the total extraction of the vanadic acid is not effected. The filtered liquid containing silica and alumina is neutralized with sulphuric acid, and then ammonia and sulphydrate of ammonia are added. The whole is left at rest for two hours to separate the silica and alumina; the filtered liquid contains sulpho-vanadate of ammonia, whence sulpho-vanadic acid is thrown down by excess of acetic acid and boiling. We can also separate vanadic acid by adding chloride of ammonium in excess, boiling, filtering, and adding to the filtered liquid a solution of tannin, which causes a blue precipitate, nearly black, containing all the vanadium contained in the liquid. M. Deville calcines the material from which vanadic acid is to be extracted with a little caustic soda, and then submits the whole to lixiviation. The filtered alkaline solution is saturated with sulphuretted hydrogen, which precipitates the silica and alumina, whilst the vanadic acid remains in solution as sulpho-vanadate of soda. In these cases the sulpho-vanadic acid is transformed into vanadic acid by roasting. These processes are somewhat tedious, and do not appear to yield all the vanadic acid present in the substance experimented on.

The method I prefer is simply a modification of Seftsröm's original process. It is applicable to any mineral substance, and gives very satisfactory results.

About half an ounce of the mineral (iron ore, clay, etc.), finely pulverized, is intimately mixed with half its weight of saltpetre, and the mixture heated to a dull red heat for fifteen or twenty minutes in a platinum crucible. The residue is treated with boiling water, to which a small fragment of caustic soda is added; it is then boiled for about a quarter of an hour, filtered, and the residue washed with boiling water. The liquid is *nearly* saturated with nitric acid, and precipitated by excess of chloride of barium; the precipitate is decomposed by sulphuric acid, the filtered liquid neutralized by ammonia, and saturated with chloride of ammonium. The whole of the vanadic acid present comes down as vanadate of ammonia in the course of two days. In some instances the process may be rendered more simple still; and for extracting vanadic acid on the large scale from iron ores, pitchblend, or from London clay, it will be sufficient to calcine a given quantity of these substances with one-fourth to one-half of their weight of a mixture of carbonate of soda and nitrate of potash; the calcination lasting about half an hour. The calcined mass is then boiled for some time with a little water, the liquid filtered, and supersaturated with chloride of ammonium. If the filtered liquid is too bulky it must be evaporated. All the vanadic acid is precipitated as vanadate of ammonia in the course of twenty-four

to forty-eight hours. This salt being collected and dried, is submitted to a careful calcination in an open crucible, the temperature being kept moderate. The vanadic acid thus produced has clear chocolate colour, and is nearly chemically pure.

In thus preparing vanadic acid on a large scale, care should be taken to employ chloride of ammonium as pure as possible. If this salt contains chloride of iron (as is frequently the case), the vanadic acid obtained will have a reddish colour, which is not observed in the pure acid.

In conclusion, I will add that Berzélius discovered that when vanadate of ammonia or vanadate of potash is added to a decoction of gall-nuts, a very good writing ink is produced, which may be said to be almost indelible; also, that I have found that vanadic acid cannot be detected in mineral substances by the ordinary blow-pipe test when a certain quantity of titanic acid is present.

UTILIZATION OF THE MAIZE PLANT.

At the Great Exhibition of 1862 specimens of paper manufactured from the Indian corn or maize plant were exhibited, and in our number for July, 1861, we mentioned that paper of this description was used in Austria for the books required in the primary schools. The present price of cotton is most likely destined before long to experience a great fall; but it is still for the good of society that fibres of other kinds hitherto neglected should be made available for the multifarious manufactures which civilization requires. It is also highly important, in this as in other directions, to utilize waste products, as the average condition of mankind cannot be materially improved so long as considerable sources of wealth and comfort are thrown away. Applied science is continually engaged in obtaining beautiful and valuable results from materials which ignorance pronounced to be good for nothing, or positively mischievous; and as necessity sharpens the inventive faculties, the dearth of cotton may, in the end, give rise to so many new manufactures and processes as to take its place amongst those numerous instances of a temporary evil evolving a large amount of permanent good.

Dr. Forbes Royle long ago pointed out a vast quantity of Indian fibre producing plants which were not utilized; but neither he nor any other scientific inquirers ever directed attention to the capacities of a vegetable body which appears better worth attention, than what is called, the refuse of the maize. Over large tracts of country in America, in Italy, in Hungary,

and elsewhere, Indian corn or maize constitutes the chief food of the population, and is produced in such abundance that the leaves and stalks can be obtained in immense quantities and at a low price. Attempts to utilize these portions of the maize plant are not altogether new, but Dr. Alois Ritter Auer von Welsbach comes before the public with what appears to be a complete scheme, and he has taken out patents for his inventions in the chief countries of the world. In a paper before us, he divides the products of maize refuse into three classes—fibrous, nutritious, and paper-pulp. He extracts from the leaves of the plant an organic substance, which he tells us resists putrefaction, and which we therefore conclude cannot be rich in the nitrogenous matters that constitute the chief value of the better kinds of food. It may, however, be good, as we are informed, to mix with flour, and it is stated to keep bread from getting, what is termed, dry—a condition which is more dependent upon molecular changes than upon actual loss of water by evaporation. We have not had an opportunity of seeing or tasting this material, but through the kindness of Martin Diosy, Esq., the Hungarian wine-merchant, in Fenchurch Street, we have received samples of the other articles which Dr. Welsbach's process affords. First, we have a handful of fibre like fine hemp; next, the same fibre spun into threads; thirdly, the threads woven into a strong coarse brown linen cloth, like fine sacking; fourthly, a strong, partially bleached cloth, of good whitey-brown colour, even texture, and considerable strength; fifthly, sixthly, and seventhly, we have finer and whiter qualities of the same kind of cloth, which the ladies of the household pronounce capable of being used for a variety of domestic purposes. After these, we find pulp for paper making, bleached and unbleached, and then comes a very interesting collection of paper of various kinds, some stiff and suited for drawing, some exquisitely transparent and firm, for tracing, others for writing and printing, some in the curious condition of parchment-paper, and others again delicate in texture, and of various ornamental tints.

It is no business of ours to go into commercial details; those who need them may be referred to M. Diosy or Dr. Welsbach; we look at the matter merely in a scientific and technological point of view, and regard the series of products before us as a very interesting illustration of how many useful things may be made out of a neglected portion of the vegetable world.

The result of operations carried on at the Austrian Government mills, near Vienna, is reported to show that three to three and a-half hundred weight of maize leaves yield forty pounds of thread, sixty pounds of paper-pulp and thirty of flour. We have no details of the process of manufacture, but it is stated to be exceedingly simple. The economical value of the plan depends upon

a variety of considerations; but where the maize is extensively grown, and there are local facilities for manufacture and transport, it would seem well worth the consideration of practical men. As the seed of the plant sells for sufficient to give a profit on the cost of cultivation in suitable localities, and as three useful substances, amounting in the aggregate to 130 lbs. out of three hundred weight of leaves, can be extracted, there is ground to hope that the process may pay. The pecuniary consideration is, however, foreign to our objects, and if we had fully studied them, we should decline offering an opinion. All that belongs to us to say, is, that Dr. Welsbach has displayed considerable technological skill in producing the series of objects that have been sent for our examination, and we hope his labours will be of value in creating a new branch of industry, and augmenting the supply of materials in daily and increasing demand.

FURTHER NOTE ON THE COAL SUPPLY.

BY PROFESSOR ANSTED, F.R.S.

My attention has been drawn to an error more unaccountable than really important, in reference to the argument in my article on the "Supply and Waste of Coal," in your last number. I have said, in page 322, that an acre of land contains 2840 square yards. I need not remark that the real figure is 4840; but what was originally, probably, a slip of the pen, I have inadvertently carried out in a little calculation with reference to the quantity of coal in each square mile, one foot thick; and again in the estimated grand total of coal under certain probabilities (p. 323), and the available remainder, in page 325. I can no more account for the error than in the case of a mistaken date; but the reader may observe that the value of the argument is really unaffected. I had no intention to do more than give a general illustration, and it matters little whether the actual quantity of coal left is estimated at thirty-five or sixty-five thousands of millions of tons, the present consumption being a hundred millions, and rapidly increasing.

The figures should be as follows:—

Each square mile of coal, one foot thick, contains 968,000 tons, and if the mean thickness is fifty feet, and the area 6000 square miles, the quantity is 290,400 millions of tons. The fourth part of this available is 72,600 millions, and the remainder 65,000 millions. This would be exhausted in a few centuries, under the supposed conditions, and economy is therefore loudly called for.

I must apologise to your readers for an error that certainly ought not to have been allowed, but of which I can give no account.

PLATEAU'S ARITHMETICAL PROBLEM—A NEW METHOD.

BY JAMES J. HOOTON.

I HAVE just read in this month's number of the INTELLECTUAL OBSERVER a translation of a paper communicated by M. Plateau to the Belgian Academy, in which that gentleman supplies a general rule for the solution of a certain problem involving the properties of numbers. It occurs to me that a more direct method of dealing with this simple matter would be to assume $N = \frac{11111\ldots\ldots}{n}$ where N is the required multiplicand, n the given multiplier, and 11111 . . . . ., a number containing the smallest iterating figure, of which any other similar number would, of course, be a multiple. Adopting this equation, it will be found by experiment that for even values or multiples of 5 given to n, the quotient of 1111 . . . . ÷ n or N will be a number with a figure or figures recurring, *ad infinitum*, and that, consequently, the problem fails for all such values of the independent variable (n). For all other values of n, the quotient is terminable, and we arrive at one result without the aid of "periodic decimal fractions," etc.

THE MELOPHAGUS, OR SHEEP-TICK.

BY L. LANE CLARKE.

(*With a Tinted Plate.*)

WHEN the farmer, careful for the well-being of his flock, gives the order for a sheep-washing, or "a ticking"—and thousands perish of the parasites which irritate the sheep—doubtless the farmer is right; we have dominion over "the creeping thing," and reason to judge of its proper rate of increase. Nevertheless, that same sheep-tick presents an interesting and thoughtful object for a naturalist, who, entering into the mysteries of organic life, gathers up every minute variation and modification, holding each as a clue to guide him through the labyrinth of Almighty wisdom, which the mere classification of genera and species fails to grasp.

Comprised within the order Diptera, or two-winged flies, we find several genera which have no wings at all: the apterous and suctorial Pulex, and the apterous and pupiparous Eproboscidæ; though amongst these latter we have the winged Hippobosca, or horse-fly, the Ornithomyia, or bird-fly, and the Stenopteryx, or swallow-fly.

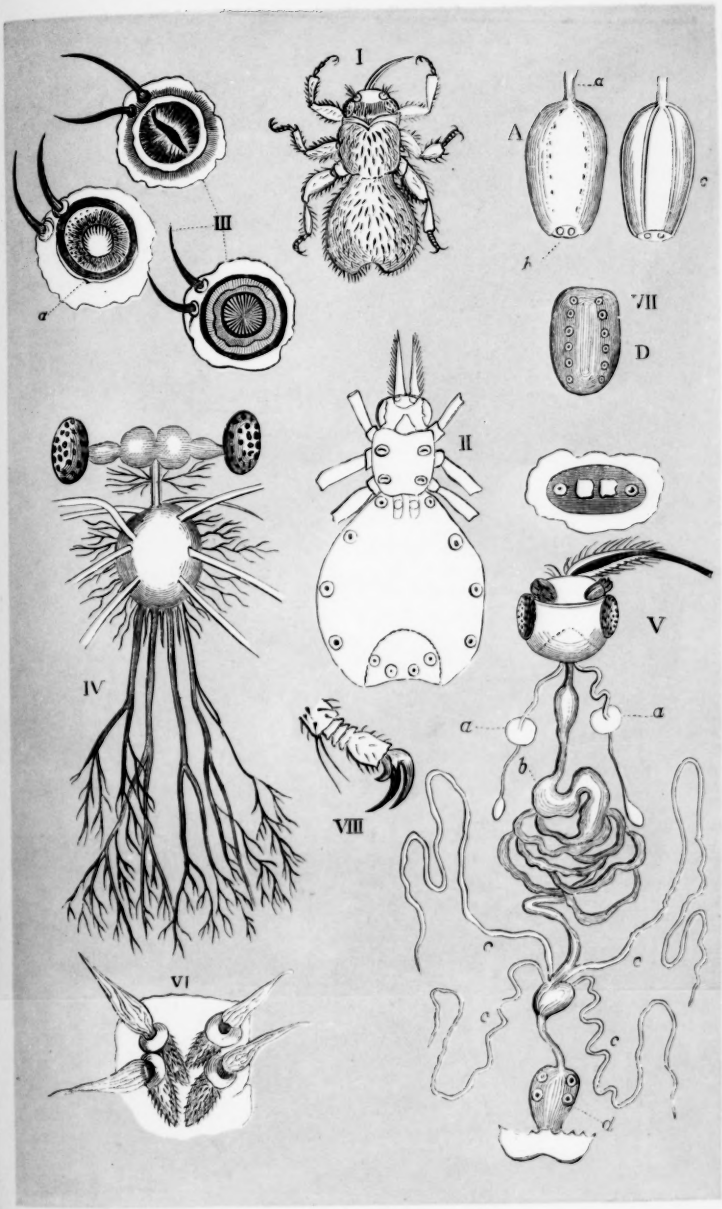
The Melophagus (Fig. I.) is apterous, and possesses some remarkable links with insects of both higher and lower organization. It is easy to procure, and makes a good object, also for the microscope, if soaked in potash, washed, dried, and mounted in balsam, when it polarizes brilliantly. For present examination we need but use a low power, and look at it as an opaque object, observing that the coriaceous, bristly body is divided as usual into three distinct parts—head, thorax, abdomen; but that, unlike the rest of the Muscidæ, the abdomen has no segments, because the system of reproduction, differing entirely from the oviparous or viviparous flies, requires an elasticity and firmness in that part which could only be obtained in a perfectly continuous substance; yet, when the female has expelled the pupa-form of her progeny, there is found, *more* or *less*, in the Hippobosca, Ornithomyia, and Stenopteryx, transverse plaits or folds of the abdomen answering perfectly to the segmentation of a dipterous abdomen, but fading quite away in the Melophagus.

We may also notice the comparatively few facets in the eye of this sheep-tick, which needs no more for its sedentary life amidst the dark mazes of the matted wool; a highly reticulated eye, like that of its nearest relative, the Hippobosca, who darts about in the sunshine, would be wasted here.

The position and strength of its legs we observe as exactly adapted for pushing through the woolly thicket, with claws like harpoons, toothed and striated (Fig. VIII.), clinging so desperately to the sheep that desperate measures are needed to relieve the animal of its parasite. These are only well seen in the mounted specimen, and so also must we prepare the insect to see the perfection of its suctorial apparatus. This is composed of a pair of hairy valves protecting a very slender siphuncle, rigid and sharp, and may be compared with that of the horse-fly, which is shorter, because exercised upon the nearly naked skin of the horse, whereas the Melophagus requires a long, flexible dart, in searching for a vulnerable point amidst the clotted wool.

The next point of interest will be the number, position, and variation of its spiracles.

It has nine pair of these breathing organs—two pair in the thorax, seven in the abdomen (Fig. III.)—round in form, and edged with simple cilia, quite unlike the spiracles of the Muscidæ; for as this insect passes its life in the suffocating atmosphere of a woolly back, it wanted every facility for inhaling the necessary oxygen, and therefore has many more spiracles, and of much less complicated form than the house-fly and its brethren. These circular spiracles dilate and contract, the cilia shorten by a muscular contraction at their base, and leave a perfectly open space. (Fig. III. *a*.)



Melophagus, or Sheep Tick.

Having briefly noticed the external structure of the Melophagus, we shall be inclined to take a fresh specimen and examine its internal anatomy; a little patient dissection will give us two very interesting observations. First, with regard to the alimentary canal (Fig. V). Opening the Melophagus with dissecting scissors under water, the whole will float out, and show the æsophagus, the convolutions of the intestine, the salivary glands, hepatic vessels, and some internal appendages, which, with a higher power, we must now observe.

This requires nice management of the dissecting needles to open the enlarged part of the rectum, on which are four small dots called by Dufour "*Les boutons charnus.*" They mark the position of four internal papillæ found in most of the Diptera, but with a modification in the Melophagus. They are slightly mentioned by Owen in his Lectures on Comparative Anatomy, but no observation is particularly made of the Melophagus, in which the papillæ instead of being smooth are covered with short spines. (Fig. VI.)

These singular organs are supplied with a branch of tracheal vessels and strong muscles; they evidently work freely in the interior of the rectum, and assist in the expulsion of fœcal matter. Probably, as the Melophagus is eminently sedentary in its habits, these additional spines act as whisks and brooms to clear the way where the muscular contractions are less powerful and frequent; or they may act as rakes and sieves to separate the passing atoms and assist in the function of absorption.

The next point of interest is the very remarkable system of reproduction, whereby these pupivarous flies are separated in rank from all the other Diptera. They are neither oviparous or viviparous.

The female nourishes a single egg within her body, attached to her by an *umbilical cord*, which egg, in its early stage, possesses two small spiracles situated at its base (Fig. VII. *b*), by which air is conveyed to the pulpy substance within, from an *open* aperture in the abdomen of its mother. As the pupa progresses, eighteen spiracles develope on the surface of the skin, small dots covered apparently with a transparent membrane until the hour of its expulsion, when each tiny window flies open, and the innumerable coils of trachea expand and contract under the rush of life-giving air.

The pupa case is brown and hard, lies loosely amongst the wool; the shepherds call them "eggs," but they are really the protecting case of a young Melophagus. At the anterior end of the pupa is a slightly marked seam, indicating the aperture by which the fly will come forth. In the Melophagus, as in the common dung-fly (Scatophaga), I observe a very distinct *ptili-*

num, which is a soft, elastic membrane, the insect is able to inflate, and wherewith it pushes open the lid of its pupa-case; moreover, the abdomen has something of the same kind, probably to push against its case, and further assist its exit.

From these few observations I think we may look with interest, if not with admiration, on the common sheep-tick, and as a whole mounted insect, it is both easy to prepare and very satisfactory as an object for the polariscope, or for study of the legs, spiracles, and suctorial apparatus.

Explanation of the Plate.—Fig. I. Melophagus, or Sheep-tick. Fig. II. Outline of Melophagus to show the position of the spiracles. Fig. III. Spiracles, open and closed. Fig. IV. The nervous system of Melophagus. Fig. V. Digestive organs: *a*, Salivary glands; *b*, Alimentary canal; *c*, Hepatic ducts; *d*, *Boutons charnus* on the rectum. Fig. VI. Internal papillæ, with the tracheal vessels exposed. Fig. VII. Fœtus, with umbilical cord (*a*); *b*, anal spiracles; *c*, front view of the same; *d*, Pupa as found in the wool of the sheep. Fig. VIII. The tarsi and claws of Melophagus.

JEWISH SHEKELS AND OTHER COINS OF ANCIENT JUDEA.

BY H. NOEL HUMPHREYS.

(*Second Article.*)

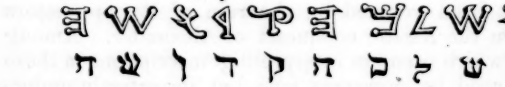
My paper on Jewish shekels, which appeared in the December No. (xxiii.) of the Intellectual Observer has brought me several communications on the subject, some requesting further information on certain details connected with this interesting subject, others suggesting a different assignation of particular coins, others only critical as to a misprint or two of the modern Hebrew characters. One correspondent asks why, in the deciphered inscription of a shekel of Yaddous (taking for granted the attribution of M. de Saulcy), of the second year, the Hebrew *i* should be omitted, as it appears on the specimen engraved in the plate. In answer to this question I may state that my interpretation was that of the inscription of a coin, now before me, in which the letter in question does not occur. I have been induced to consider it as a blunder of the engraver, seeing that a good and sufficient meaning has not been suggested for it. Some numismatists have thought that it expressed the *dual* form, in allusion to the second year; others, again, assuming the coin to belong to Simon Maccabæus, pretend that the *dual* form was intended to have refer-

ence to two distinct portions of the city, one superior to the other—the latter not being fully in possession of Simon Maccabæus till the second year of his issue of coined money; but this is an improbable straining after a meaning which cannot, I think, be accepted. I would rather accept it as an expression of the genitive, which would have more plausibility, as being in accordance with the usual Greek form of numismatic inscriptions. This, however, I think is also inadmissible. I have, therefore, taken the inscription as it stands on the shekels of the first year, without the *Iod*, and supplied the ה (*heh*), which is omitted in the inscription of coins of the first year. There are many difficulties connected with the interpretation of monetary inscriptions in the ancient Hebrew characters, commonly, but incorrectly, termed Samaritan. This old form of character had long been disused except for certain monumental purposes, and, from its infrequent adoption, it is not unlikely that blunders were sometimes made by mechanical engravers, just such as we find on our own mediæval coinage.* More especially so at a time when the old letters were very suddenly called into more general use for the first Judaic coinage, to which it was thus sought to impart a national character. That such a revival of the ancient alphabet should have been adopted for such a purpose appears natural, when it is considered that the style of the *square* Hebrew (as it is termed) was formed during the captivity, and therefore bore the stamp, as it were, of the slavery (as having been acquired in Assyria. It was sometimes called Assurith) from which the nation had just been rescued by the ruin of its oppressors consequent upon the Asiatic conquests of Alexander. Among the difficulties which occur in interpreting inscriptions in these characters, as used by engravers who but imperfectly understood their value, is the following, which has not, that I am aware, been noticed by numismatists:—I have often doubted whether the aspirate *heh*, as a definite and separate character, existed in the most ancient form of that alphabet. Consequently it is not easy to decide whether the character represented (in the deciphered inscription at page 332 of the last December part of this publication) by the English equivalents 12 and 13, and 21 and 22, be a *heh*, followed by a non-written vowel a (א), or whether it be a form of the old Hebrew א carrying with it its own aspirate. The form of the character is very like the ancient form of aleph reversed and set upright, as for

* Even in the Jewish series many obvious blunders of the engraver occur—for instance, on a coin of Herod the Great we find HR, the Latin R having been erroneously substituted for the Greek, and as in the coin struck on the reduction of Jerusalem to the form of a Roman colony. the word Capitolina is spelt KAPITOLINA, with a Greek Kappa.

a special purpose. Of such methods of changing the value of a particular letter we are not without examples. For instance, when, as on the most ancient incused coins of Sybaris, the Greek sigma, is written *flatwise*, thus ⋹, it has been thought probable that, in that position, it represented the broad SH sound of the Hebrew and Phœnician character from which it was derived; while, in its subsequent upright form, it represented the sharper sound of the clear Greek sigma (Σ). Again, *initial* and *terminal* letters in the more ancient systems of writing had generally a special value. The Greek *eta*, for instance, at the beginning of a word, represented an aspirate, as in HXATON, while, in the middle of a word, it was used as a long *e*. It was the custom, in Oriental systems of writing (in which, as it is well known, the vowels in the body of w ›rds were omitted), to express them when at the *beginning* or *end* of a word; of which many curious examples might be cited in the Egyptian system. I have thus been induced to consider the character in question rather in the light of an aspirated aleph, being the old character changed in its position, like the Greek sigma, to give it the sharper value. Having taken that view in my paper of last month, I now supply another notation of the interpretation in which the more commonly accepted value of the character is given, which, being read from right to left, gives Jeroushalem Hakedoushah (Jerusalem the holy).*

12 11 10 9 8 7 6 5 4 3 2 1



ת ש ו ד ק ה כ ל מ ו ש ו י

H(a)HS UO D(e)K(a)H M(e)L(a)HS UO R(e) I

With regard to the types or devices of this interesting series of coins (namely, the first shekels attributed to the high priest Yaddous), a correspondent, wishing for information, asks if they are all alike. On the contrary, there are several varieties, and numismatists are not agreed as to the precise import of some of the devices used, not even of the two most common ones which I selected as the most interesting. The vase which I have called the *Omer* of manna—an interpretation which the

* In comparing this inscription with that of the article in the December Number, the reader must correct the errors of the printer in setting up the modern Hebrew letters appended to that inscription. At No. 1 there should be י (yod); at Nos. 4 and 5, and also at Nos. 17 and 18, there should be ו (vau). Similar errors occur in page 341, line thirty, where כ (caph) and ר (resch) should replace ב (beth) and ד (daleth).

passages cited, and many other reasons, render the most probable—is considered by Cavedoni to be the sacred vase which was used to contain the wine prepared as an offering to Jehovah, while the small pellets sometimes placed at each side of the vase are fancifully supposed by some to represent the loaves which were placed on the table of proposition. Their small size, however, renders this interpretation open to objection. The type which has long been considered as "Aaron's rod" is considered by several eminent numismatists, M.M. Longperier and De Saulcy among the number, to be the same object as the triple flower represented in the hands of the pontiffs on the bas-reliefs of Nineveh. If this be so, and that symbol be accepted as a priestly badge or ensign, the issue of these shekels under immediate priestly authority, in a state governed by a pure theocracy, is further authenticated, and their assignation to the priesthood of Yaddous appears the more probable. Dr. Levy, however, a German numismatist, has proposed to return to the old system, and reassigns the coins in question to the epoch of the Maccabees. The style of the workmanship of these coins, however, does not at all accord with the already debased style of the neighbouring Syriac coinage at that period, while it very closely resembles that of the earlier Greek period of Alexander, and still more closely that of the Persian satraps of Tarsus of the same epoch; rendering the theory of M. de Saulcy, on the whole, the most probable in the present state of our knowledge.

The copper pieces of the fourth year have as types, in addition to the sacred vase, the *loulab*, or bunch of green leaves that was carried in the right hand to the temple on the festival of the Tabernacles, and also the cedar-cone which was carried in the other hand.* The large pieces have also a date-tree, with fruit, which was evidently a national symbol; that emblem, as well as the cedar-cone and the loulab, being adopted by Barcocebas on the coins which he issued during the last revolt in the reign of Hadrian.†

In reply to the correspondent who wishes for illustrations of the coinage of Herod, especially a piece bearing the eagle type, suggesting that the appearance of the eagle on that coinage has an interesting historical significance, my answer must be want of space, both for that and several other matters of interest omitted with regret. I however disagree with my correspondent as to the *kind* of interest which attaches to the coins of Herod of the eagle type. He states, which I believe is also the opinion of a very eminent numismatist, that the eagle was placed by Herod on the coinage as a sort of defiance to the

* See Leviticus xxxiii. 40.

† See the paper, "Jewish Shekels," in the December Number.

people of Jerusalem, who had torn down and destroyed a golden eagle which he had placed over the chief entrance to the temple; the introduction of such a form being considered idolatrous, and opposed to the ancient principles of Jewish law. My explanation of that type would be, that as on the coinage of the Asmonean or Maccabæan line of princes the types of the anchor and the cornucopiæ (which were symbols belonging to the Syrian princes of the Selucidæan dynasty) were adopted to express a friendly alliance with the sovereign of Syria; so the eagle (the emblem of Roman power) was used as a monetary type by Herod, the Idumean usurper, to denote his close alliance with Rome, without which he would have been unable to sustain his usurpation of the right of the legitimate princes of the Asmonean line. The same correspondent asks if I can explain the tripod type on the coins of Herod. I presume he alludes to the one engraved below. It is a burning altar, and is supposed to have reference to the re-consecration of the Temple after its splendid restoration in the fifteenth year of his reign. This view is not borne out by the date, year 3, though the coins appear to be of that epoch.

I may observe here that the two sons of Herod, Archelaus and Antipas, preserved the name of their father Herod; and Antipas, who was denied the title of king by the Roman Senate (or, more strictly speaking, the Roman emperor), but received the title and powers of Ethnarch of Judæa—placed no other name upon his coins than that of Herod, represented by the initial letters of the name in Greek, as HPΩ, and his title of Ethnarch abbreviated as EΘN.

It should be stated, as a learned French numismatist has observed, "Que le dernier mot n'as pas été dit sur la numismatique Judaique." Indeed, the question is far from settled. M. Lenormant, M. Longperier, M. Vogüé, and many others, are for removing most of the coins formerly attributed to the first, second, third, and fourth years of the Maccabæan dynasty, to an earlier period; while Dr. Levy and others have since declared for reinstating them. The question at issue is by no means decided. "The last word has not yet been said." It is at all events sufficiently clear that coins bearing the impress of workmanship of evidently distinct epochs of art, cannot be classed together as belonging to one historical period. In the mean time, I have endeavoured to give such a general view of the subject, from its earliest treatment by modern numismatists,

as may enable the general public to follow and appreciate the new views on the subject which are from time to time appearing; especially the logical and very complete theory of M. de Saulcy, from which, however, I have ventured to differ in some particulars.

Among other remarks of my correspondents on the subject, it has been suggested that the date on the coins issued under the auspices of the first Roman Procurators of Judæa is that of the era of Augustus, and *not* that of the battle of Actium. I think it probable that it may be so, but the dates only differ by three or four years, and I have therefore thought fit at present to follow the great authority of Eckhel, who calls it the Actian era. Cavedoni, another very good authority, considers it to be the Alexandrian era; while both the Actian and Alexandrian eras bear reference to the first establishment of the power of Augustus throughout the eastern possessions of Rome. The coin engraved below is one of the coins in question, bearing date the 39th year, ΓΘ, which was misprinted in the former article.*

The same correspondent observes that the inscription ΒΑΣΙΛΕΩΣ ΑΓΡΙΠΠΑ should be ΒΑΣΙΛΕΩ ΑΓΡΙΠΠΑ, with one Π. He is not aware, it would seem, that the inscription occurs in both forms, as D. Cavedoni expressly states. My correspondent further suggests that the coins with this inscription all belong to Agrippa I. D. Cavedoni, on the other hand, gives them all to Agrippa II., and says nothing of coins belonging to Agrippa I.

Another remark I have to reply to is, that, according to my correspondent, the Emperor Titus, in the coins of the celebrated JVDAEA CAPTA type, places his foot upon a helmet, and not upon a clod of earth, as I have stated. It is true that in many of the devices of that class it is so; but they vary very considerably, even in the more important features. Many which I have examined have the object on which the emperor places his foot of such irregular shape, that it is impossible to trace the form of a helmet by the utmost stretch of imagination. I have, therefore, in describing the coin before me, presumed it to be a clod of earth, seeing that in other Roman devices of a similar class a figure seated on a small mass of rock is intended to symbolize a taking possession of territory.

ERRATA FOR THE DECEMBER NUMBER, 1863.—In the interpretation of the inscription at page 332, the Hebrew letter at No. 1 should be י (yod), instead of ז (zain), and at Nos. 4 and 5, and 17 and 18 there should be ו (vau) instead of י (yod); at page 341, line 30, ב (beth), and ד (daleth), should be respectively כ (caph) and ר (resch); at page 338, line 35, for ΠΡΩ read ΗΡΩ; at page 340, for ΒΑΕΙΛΕΩΕ read ΒΑΣΙΛΕΩΣ; at page 318, read Λ. Γ Θ (year 39).

* The Λ.ΓΘ is very indistinct, and the Λ of ancient form.

The coin engraved below is one of those struck on the occasion of the final suppression of Jewish independence, in the reign of Hadrian, after the revolt of Barcocebas. It bears the name of the colony, abbreviated, which in full would be COLONIA AELIA CAPITOLINA: beneath, in the exerque, are the letters COND, being an abbreviation of the word CONDITA (founded). The type is the old colonial one of the Romans, the two bullocks at plough, in allusion to an ancient and primitive Roman custom of attaching as much land to a colony as two bullocks could encircle with a furrow in a single day. The standard behind the bullocks intimates that the colony is a military one. The obverse of this coin has the head of the emperor, laureated, with his name and titles.

CLUSTERS AND NEBULÆ.—OCCULTATIONS.—THE ACHROMATIC TELESCOPE.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

CLUSTERS AND NEBULÆ.

We shall have little trouble in recognizing the next object if the telescope is competent to show it. It is by no means remarkable in itself, but, should the suspicions entertained concerning it be verified, it will prove one of the most curious objects in the heavens.

6. *The Nebula in the Pleiades.*—1859, October 19. Tempel at Venice discovered with a small instrument a previously undescribed nebula close to the star *Merope* in that group, which he says was large and bright, and twinkling in places, similar to a beautiful bright comet.—1860, December. Peters and Pape at Altona, in tolerably favourable weather, could only perceive it with difficulty in a 6-feet telescope.—1862, Aug. D'Arrest and Schjellerup, with the new great Copenhagen refractor, of about 11 inches aperture and 16 feet focus, could not find it in nights when a nebula called "extremely faint" by H_3 and "excessively faint" by H was not only easily distinguished, but seen double. Such an apparent change in connection with the fact that a similar and contemporaneous decrease of light had been noticed in two other nebulæ in the same region, of course excited great interest. Familiar as observers have become with the marvellous phenomenon of variable brightness in stars, the evidence of which is rapidly accumulating with each succeeding

year, there is something in the idea of a simultaneous variation in a whole assemblage of stars, as we have already pointed out in the case of the nebula in Orion, which seems to pass the bounds of probability, and inclines us rather to the alternative of luminous mist. The question, however, as to whether this nebula—so curiously situated among the Pleiades—is actually variable, can hardly be considered as decided, notwithstanding the evidence which has been adduced. Schmidt, the present director of the observatory at Athens, is strong on the affirmative side. He states that he has been in the habit of watching the Pleiades more or less since 1841, and commenced drawing them in 1844, and that between that date and 1860 he had observed them on thirty-two nights; his comparisons of brightness, several hundred in number, being intermitted only in 1846 and 1859; but that during all this time he had never seen the nebula. He thinks it could not have escaped him had it been visible in 1861 with a 4-feet Dollond; February 5th in that year he saw it for the first time with the refractor at Athens (probably a Dialyte by Plössl, of $7\frac{1}{2}$ [French ?] inches aperture; but not, as it seems, of the highest quality). The air being quite clear, it appeared very large, very pale, and quite shapeless, *Merope* lying in its N. corner, so as to appear a nebulous star in comparison with its brilliant neighbours. Between this date and the end of 1861 he saw it two or three times.—1862, March 26th, he finds "the great triangular nebula in the Pleiades easily visible; its extension towards the west is, however, much greater than I had previously believed." On the other hand, Schönfeld at Mannheim doubts the fact of variation. He saw it, 1862, September 20th, not fainter than in 1860, as Chacornac had done at Paris two nights previously; and he thinks that this and the other suspected nebulæ, being very feeble, large, and diffused, are influenced in visibility by magnifying power, varying transparency of air, and practice of the eye, so that aperture is less concerned in their case than in that of minute stars. Auwers, of Göttingen, argues on the same side. It has often, this observer says, been remarked—Encke's comet being an instance of it—that large, ill-defined, faint objects are best seen with small instruments, and that probably this nebula, having 15′ of extent, filled D'Arrest's field under a considerable magnifier, and so became inconspicuous; he found it an easy object in a comet-finder of 2 feet focus, and saw it repeatedly;—1860, September 23rd and 24th, when only 16° high; 1861, January 14th; 1862, February 19th and 21st. From its size it can be distinguished with only twenty-one lines of aperture ($1\frac{3}{4}$ French inches).—Winnecke, again, the assistant at Poulkowa, saw it with 4 French inches in March, 1862, large and ill-defined, yet easily visible, as it was also in a

comet-finder; on the contrary, the director, Otto Struve, could only satisfy himself that it was perceptible in the great achromatic of $14\frac{3}{4}$ inches with a power of 150, by moving the tube to and fro.—1862, September 29th, it was very easily visible at Poulkowa with two smaller instruments, and even the comet-finder of about three inches aperture, which also shows some nebulæ considered to be very faint; extent being, in such cases, according to Winnecke, the condition of visibility—a conclusion which we have certainly seen borne out in the instance of No. 4 of our present list.

These details, which, under other circumstances, might be thought tedious, appear admissible in an inquiry, the result of which may prove of very great interest; and whichever side may ultimately prove to be right, the object is certainly curious enough to deserve a search. I was thus employed a little before the earthquake in the early morning of October 6; when, as I had so far lost sight of the foregoing particulars, that the utmost of my recollection was that of a large faint triangular object, including in one corner one of the brighter Pleiades, my result, if any, was likely to be tolerably unbiassed. On turning the telescope upon the group with powers of 29 and 64, though I probably should not have discovered it unknown, I found it with ease, as a very ill-defined, but on the whole egg-shaped haze, encompassing a brilliant star with its smaller but rather brighter end. A defective comparison with a diagram frustrated the identification of the spot on the following day; but on reviewing it, November 10, I found immediately that the star was *Merope*, and the glow connected with it the nebula in question. Students who wish to find it have only to point the telescope, with a low power, to *Alcyone*, the *lucida* of the Pleiades, readily distinguished by its beautiful appendage of a triangle of little sparkling gems; then *Merope* will be the next bright star *s p*, and the nebula will be seen encompassing it, and stretching away in feeble and diffused light towards the *s*, a little *p*, its greatest extent being, from a comparison with the field of my comet eye-piece, about 17′, or nearly the distance between *Merope* and *Alcyone*. Obscure as this object is, it may possibly prove a most important witness as to the existence of luminous matter in an unconcentrated form. It does not, however, stand alone, or the inference, from such disputed grounds, might appear very inconclusive. Two other similar instances, as we have observed, are suspected, and, strangely enough, in the same region; the best authenticated being at 9° distance, nearly in the direction of Aldebaran. The student, though he would now look in vain for this mysterious nebula, may be glad to see its data, as given by D'Arrest and Auwers. 1852, October 11, discovered by Hind,

faint and small, with a 7-inch object glass; 1854, seen by Chacornac at Marseilles; 1855, November, December; 1856, January, easily distinguished, even in moonlight, at Leipzig, with a 6-feet telescope; 1855, 1856, observed by Breen, with the Northumberland telescope at Cambridge; 1858, February, March, seen faintly at Göttingen with 6-feet achromatic; 1861, Königsberg, 8-feet heliometer, October 4, traces conjectured; November 3, in remarkably clear air, not a vestige of it, nor had it been seen there up to 1862, April 2; 1861, October 3, invisible in the great Copenhagen achromatic; 1862, January, sought in vain with the great Foucault silver-on-glass reflector at Paris, 27 inches in diameter, as well as by Hind and Secchi. Nor was Lassell able to perceive it, even with 48 inches of metal, in the pure sky of Malta; the Poulkowa achromatic alone continuing to show some feeble appearance of it in 1861 and 1862. This is marvellous enough, but the wonder is increased by the fact that a small star, only 1′ distant from it, has sunk, between 1852 and 1862, from 9·4 to 13 or 14 mag. The coincidence, to say the least of it, is sufficiently strange to arrest our watchful attention, especially in connection with Otto Struve's views as to the probability of variable light, not only in certain parts of the nebula in Orion, but in some of the minute stars involved in its extent.

7. *The Crab Nebula.*—In the directions for finding No. 75 of our Double Star List (Intellectual Observer, Feb. 1863, p. 55), the position of *ζ Tauri* is pointed out: this star will readily guide us to a nebula lying rather less than 1° *n p*, which, though inconspicuous in itself, has become well known from the commonest of its portraits. It is No. 1 of Messier's list, having been discovered by him in 1758. He was observing the position of a comet near *ζ Tauri*, when he perceived it as "a whitish light, elongated like the flame of a taper;" and was thus induced to undertake his useful Catalogue. Smyth remarks that it "was also a mare's nest to more than one astronomical tyro in August, 1835, when on the look-out for the return of Halley's comet." The Admiral describes it as a large, oval, pearly-white nebula, brightest towards the S. In Sir J. Herschel's Catalogue, where it stands 357, it is stated to be 4′ long, 3′ broad; very gradually a little brighter in the middle, and resolvable. But a grand change was wrought in its aspect by the three-feet speculum, which was the earlier fruit of the Earl of Rosse's labours; he observes that "it is no longer an oval, resolvable nebula: we see resolvable filaments, singularly disposed, springing principally from its southern extremity, and not, as is usual, in clusters, irregularly in all directions . . . . . it is studded with stars, mixed however with a nebulosity, probably consisting of stars too minute to be recognized." I have

not met with any subsequent report of the action of the six-feet mirrors upon it. Its common name is derived from the branching filaments, in which some resemblance may be fancied to the claws of a crab; but the student must be content to trace it in the engravings which are often met with, as no ordinary instrument will touch these appendages, and they were not remarked even by Sir J. Herschel. With a small aperture it will be found a feeble object, though very distinguishable from its magnitude; with my $5\frac{1}{2}$ inches I thought I could see a mottled character pointing to resolution, and its edges, being known to be actually fringed, were suspected to look so.

A short distance from ζ, p, a little n, we shall find a pretty little open double star.

ADDENDUM *to No.* 4, *in our last number, p.* 351.

I have since ascertained that with the six-feet speculum of the Earl of Rosse the brightest part of the great Nebula in the Triangle has been found to exhibit that marvellous spiral arrangement, to which we shall have to refer more fully hereafter. From a common centre spring four thick branches (with a mere suspicion of a fifth), somewhat like the arms of a cross, of unequal length, but each *curved in the same direction.*—Three observations, 1849; at the last of which the whole nebula was seen in "flocculi." No other portion of it seems to have any definite arrangement.

OCCULTATIONS.

Jan. 15th, π Piscium, 6 mag., will be hidden (at Greenwich) from 12h. 8m. till 12h. 44m. 19th, l Tauri, $5\frac{1}{2}$ mag., from 12h. 2m. till 12h. 38m. 20th, χ^1 Orionis, $4\frac{1}{2}$ mag., will disappear at 7h. 57m., and reappear at 9h. 13m. 24th, κ Cancri, 5 mag., at 6h. 30m. and 7h. 15m. respectively.

THE ACHROMATIC TELESCOPE.

THE statistics of telescopic improvement and diffusion, if attainable, would form a curious subject of inquiry. Many an astronomer now living well remembers the day when an achromatic telescope of even $3\frac{3}{4}$ inches aperture was the largest that could be found as a portion of the optician's regular stock, and was by no means a cheap article, while those of greater dimensions were as scarce as they were costly. Now, those of the larger class are perhaps almost as numerous as the smaller ones were not many years ago; and it is at the same time a very gratifying consideration that this remarkable increase both in quantity and size has not been attended with any deterioration of quality, but rather the reverse. It may be doubted whether the high character which was ascribed to some of the earlier achromatics was other than comparative. They could not appear

excepting to advantage, even beyond their real deserts, after the cumbrousness and unwieldiness of the old refractors in whose place they succeeded; and those which are now in turn replacing them are certainly often of previously unattained excellence.

The great extension, however, of the means of observation has probably not been accompanied with an equal amount of information as to their nature; and many an amateur may be working with a tool, the principle of which he would find interesting if he did but understand it. Such information is certainly not essential to success, but as it involves some remarkable optical facts, our readers will perhaps not be displeased with a simple account of the construction of the ordinary achromatic telescope, as well as of its various modifications.

As we are not going to write a treatise upon Optics, some obvious preliminaries may be taken for granted; and we shall consider it to be generally understood that lenses of glass, or other transparent material denser than air, if their curves are predominantly convex, cause the rays of light to converge to a focus, where they form a picture of any object from which they have issued. A spectacle lens for an aged sight placed against the keyhole of a door of a darkened room, with a piece of white paper in its focus, gives a pleasing illustration of this, and every burning-glass is an instance of it, the little fiery spot being a picture of the sun, frequently attended by that of the bright clouds immediately around it. This focal image does not require a screen of paper to render it visible if the eye is placed at a suitable distance behind it, so as to receive the rays after they have crossed at the focus: it will then appear as a picture of the object beyond the lens, always inverted and enlarged, if the focus is sufficiently long; but, as the magnifying power thus obtained is inconsiderable, it is necessary to interpose between the picture and the eye a lens of short focus, or combination of lenses, which, acting precisely the same part as a microscope, will form a greatly enlarged image on the retina, and in so doing produce the simplest kind of telescope.* It is evident, therefore, that the quality of such a telescope, and, in fact, of all telescopes, will depend upon the accuracy of the focal image, every defect there being absolutely irremediable afterwards, and only made more conspicuous by each increase of magnifying; and accordingly the first object of the optician is to obtain as great perfection as possible in the formation of the picture in the focus. To produce this there must be good material, not only as transparent and colourless as may be, but (what is much more important) of uniform density throughout;

* This is not, however, the Galilean construction; which, though equally imple, does not admit of an equally ready explanation.

any irregularity in this respect having the effect of refracting the rays which encounter it more or less than their neighbours, and thus seriously impairing their accurate conveyance; good workmanship, too, is highly important—not merely brilliancy of polish, which, though very desirable, is not essential, but still more accuracy of form, any deviation from the correct curve being fatal to excellence. But, supposing all these combined, a single convex lens will not, after all, produce an accurate picture, or, optically speaking, form a good object-glass: and the cause of this imperfection may be well illustrated by means of a common reading or burning-glass. If we hold it in the sun and examine carefully, by receiving them upon a card or piece of paper, the appearance of the rays as they proceed towards and beyond the focus, we shall find, 1, that the circumference of the bright circle formed upon the paper is more luminous and sharply defined before reaching the focus than afterwards;—and, 2, that in the former case the circle is bordered by a narrow fringe of reddish orange, which beyond the focus is changed to a bright blue. Either of these peculiarities injures the distinctness of the picture, and each requires separate consideration.

As to the first defect, the condensation of light towards the edge of the rays converging to focus, it arises from the fact that it is not possible for a spherical surface, or any portion of one, to collect the rays passing through it in one point. The cause of this cannot be explained without a considerable knowledge of the mathematical law of refraction, upon which we must not here enter; it is sufficient to state that it requires that the rays refracted at a spherical surface should converge to foci nearer and nearer to that surface, in proportion as the surface is more highly inclined to the direction of the incident or emergent ray. Hence, the focus of the margin of a convex lens is perceptibly shorter than that of its centre—a fact which may be experimentally shown by so covering a reading or burning-glass with paper, that a narrow ring shall be left exposed all round the edge, and a small opening in the centre: if the lens is then held in the sunshine, and a card moved backwards and forwards through the focus (care being taken to keep both lens and card at right angles to the direction of the solar rays), it will be found that the ring formed by the marginal rays will converge to a point short of that reached by those from the centre, and that, being crossed by these latter rays, it will not be sharply defined; while the image from the central opening, formed further on and more distinct, will be surrounded with the re-opening luminous ring.* This defect,

* This experiment may be tried by candle-light, as a strong sunshine would be found very dazzling.

which is known by the name of "spherical aberration," or sometimes "aberration" alone, may also be illustrated by the diagram at p. 215 of our number for April, 1863, where a corresponding, though not precisely similar, defect is shown to be the result of employing a spherical surface in reflection.

The second source of error is of an entirely independent nature, arising from the unequal refrangibility of the rays of different kinds of light. If all the coloured rays which by their union compose whiteness, were acted upon to the same extent by refraction, they would still remain united under whatever circumstances refraction might occur, and no decomposition into colour could ever take place by any process of this kind. But such is not the case. Red light is invariably less bent from its course than yellow, yellow less than blue; and, therefore, refraction never takes place, even in the smallest degree, without a corresponding separation of the light into the primary colours of red, yellow, and blue, which by overlapping and partial combination produce the seven colours of the rainbow. The focus of the red light will for this reason be furthest from the lens, that of the yellow intermediate, and that of the blue shortest, the intervening spaces being filled up by various combinations of colour;* and whichever focus we may assume, the image there produced will not merely be deficient in due brightness, being formed by a portion only of the rays proceeding from the object, but will be bordered by fringes formed by the other colours converging to their own independent foci. The general cone of rays, as intercepted on a paper screen, will appear white, for though the whole mass of light is actually decompounded, an infinite number of cones of different colours being really produced by the infinite number of concentric rings of which the lens may be supposed to consist, yet as these all overlap and intermingle with each other, the whiteness is recomposed throughout. The outermost colour, however, having nothing to overlie it, crops out, as it were, in the form of a tinted border, and thus the general cone within the focus is fringed with the less rapidly convergent red, and beyond the focus by the more refracted blue, which having converged to a point nearer to the lens, but invisibly so, being neutralized in the general cone, crosses the general mass (confusing the other foci in its passage), and becomes outermost in the subsequent divergence.

This may be exemplified in an interesting manner by stick-

* The innermost focus is actually, as it is generally stated to be, that of the violet light; but we have taken no notice of it in the present explanation, partly because, according to Sir D. Brewster, it is not a primary colour, but compounded of the extreme red and blue rays, and partly because it is not of sufficient intensity to be recognized in these experiments.

ing upon a reading-glass a circular piece of paper of a somewhat smaller size as in the previous experiment, only omitting the central hole, and holding it up to the sun; the interior of the cone being thus stopped out, each side of the remaining ring will be found bordered with colour, and the red and blue fringes will change places in passing through the focus.* This separation into colour is technically termed "chromatic aberration," or more frequently "dispersion."

From the combination of these two sources of error, the focus of a simple refracting telescope, instead of being, as it ought to be, a single point uniting the whole body of converging rays, is a circle of appreciable magnitude, being the smallest common section of a number of cones meeting and crossing each other in different points, its size being determined by the distance between the extreme foci on either side of it: and consequently the image of every point in the object viewed will be a small, discoloured circle; and every outline in nature, which may be considered as made up of contiguous points, will be misty and ill-defined in the focal image, and exhibiting its imperfection still more in proportion as it is magnified by the eye-lens, will render telescopic performance very unsatisfactory. We must now consider what remedy may be applied to each of the defects whose united influence is so prejudicial.

1. The spherical error can be perfectly removed in theory, as was pointed out by Descartes, by making the exterior surface of the lens a portion of an ellipsoid or hyperboloid, instead of a sphere. But the extreme difficulty of working glass to any other than a spherical or flat surface rendered this discovery of no practical use: the amount of the aberration indeed, varying with the curves of the surfaces, may be much reduced by so combining them as to produce a *minimum* effect; but it never can be altogether annihilated.

2. Dispersion, which is the far more serious evil of the two, as introducing a much greater angle of deviation, is perfectly irremediable in its own nature, being an inseparable portion of the refraction by which the focal image is formed. Some transparent media possess a greater, others a less dispersive power; or, in other words, the interval between the red and blue foci differs somewhat according to the material of the lens: but the substances which occasion less proportional dispersion than glass are too expensive, or too unmanageable, to be employed with advantage, the difference, after all, being of no great amount.

* This experiment may be varied in a pleasing manner by covering the whole lens with a piece of paper, pierced with a great number of small holes, chiefly, however, towards the edges, as near the centre the discolouration will scarcely be perceptible.

Such are the defects of the simple refracting telescope; which depending, as we have seen, upon optical laws, and inherent in the construction, are irremediable, excepting by a modification of the construction itself. Fortunately for the interests of science, such a modification is possible, and has been effected with admirable results: but the explanation of it must be deferred to a future time.

LITERARY NOTICES.

MANUAL OF THE METALLOIDS, by JAMES APJOHN, M.D., F.R.S., M.R.I.A., Professor of Chemistry in the University of Dublin. *Longmans.*—This work belongs to Galbraith and Houghton's series of scientific annuals, and is intended as a "Hand-book in Chemistry for Students in Medicine and Engineering." We should assign to it a much wider range of utility, as it appears to us an admirable introduction to chemistry, for students of all kinds. There is some inconvenience in publishing a manual of the "metalloids" by themselves; but we presume the chemistry of the metals, and of organized bodies, will follow sufficiently soon to enable the subscribers to Messrs. Galbraith and Houghton's series on "Experimental and Natural Science" to have a complete work on chemical science without much delay. Any division of substances founded on their chemical relations must necessarily partake of the incompleteness arising from imperfect knowledge; but as a provisional plan, little objection can be made to the formation of two groups, metals and metalloids, provided it is remembered that the division is purely empirical, and not intended to embody any well-established theory. According to this plan, opaque, highly lustrous bodies, which are good conductors of electricity and heat, are called *metals*, while the elementary gases, sulphur, selenium, tellurian, chlorine, bromine, fluorine, phosphorus, arsenic, boron, silicon, and carbon are lumped together under the designation *metalloids*.

Dr. Apjohn is too sound a thinker to be satisfied with this arrangement; but there can be no doubt, that in the study of chemistry the so-called metalloids should be presented to the learner before the metals, and in the order in which they occur in his book. The new manual consists of two portions—an introduction of 105 pages devoted to the theoretical portion of chemistry, and the main body of the treatise, in which the several metalloids and their compounds with each other are briefly but compendiously described. So far as the latter part is concerned, Dr. Apjohn appears merely as an able compiler, and we do not notice any particular novelty in the treatment; but the introduction constitutes a work of great merit, in which his skill as a teacher is conspicuously displayed. We doubt whether it would be possible to point to any other book in which so many important facts and doctrines of chemical philosophy are so briefly and so intelligibly explained. In this section we find the laws of combination, equivalent numbers,

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atomic weights, chemical notation and nomenclature, the relations of atomic weights, law of volumes, atomic volume, the unitary system of atomic weights, isomerism, isomorphism, dimorphism, the reaction of bodies on each other, the views of Berthollet on the causes of decomposition—all presented in the clearest way. Dr. Apjohn works up logically from those simple ideas that are easily apprehended, to the more complex propositions assembled under the various heads we have cited, and it will not be his fault if those who read his book do not learn to *think*, as well as to recollect the bare facts of the science. We particularly admire the skill with which he has avoided the suggestion of fallacy that is inseparable from a metaphysical treatment of chemistry. He keeps strictly to facts, and when discussing theoretical views, such as those of Berthollet or Gerhardt, he is singularly fair, and ably discriminates between the judicious use of an hypothesis, and its premature acceptance, or rejection, upon insufficient grounds.

The Flora of Surrey; or, a Catalogue of the Flowering Plants and Ferns found in the County, with the Localities of the Rarer species, from the MSS. of the late J. D. Salmon, F.L.S. Compiled for the Holmesdale Natural History Club, Reigate, by James Alexander Brewer. *Van Voorst.*—Botanists and collectors will appreciate the great labour necessary for the production of this useful work; and we congratulate the Holmesdale Natural History Club on having made so important an addition to local natural history. The work is enriched by two large maps—one copied from a geological chart of the county, prepared by Joseph Prestwich, Esq., and the other arranging the county into botanical divisions corresponding with references in the text. An appendix exhibits the geological distribution of the plants; and there are two indexes—one giving the scientific names of orders and genera, and the other the common English names of species. On comparison, it appears that "the plants of Surrey are $\frac{2}{5}$ths of those of the United Kingdom;" that the Surrey Dicotyledons amount to $\frac{7}{11}$ths of those of the United Kingdom; the Monocotyledons to $\frac{2}{3}$rds, and the ferns and their allies to $\frac{1}{2}$ ditto.

Flora of Marlborough, with Notices of the Birds, and a Sketch of the Geological Features of the Neighbourhood; with a map. *Van Voorst.*—Mr. T. A. Preston states, in the preface, that this list is the result of five years of his own botanizing, and he invokes the labours of others to render it more complete. It has been especially compiled for the students of Marlborough College, and is confined to a circle having a radius of six miles from the town, of which a photographed map is given. The work affords another pleasing and useful instance of attention to local natural history; and we hope Mr. Preston will succeed in imparting to the Marlborough students a love of such pursuits.

Dictionary of Natural History Terms, with their Derivations, including the various Orders, Genera, and Species, by David H. M'Nicholl, M.D., Member of the Royal College of Physicians. *Lovell Reeve and Co.*—The enormous number of technical terms,

and the prodigious quantity of compound words that make up the nomenclature of natural history, render it physically impossible that the whole of them could be comprised within the limits of a volume which many students could afford to buy, and therefore dictionaries compiled upon the principle of selection are to be commended. Dr. M'Nicholl has given as many words as can be printed in 584 fair-sized pages, in moderately small type. His collection is therefore very large, and his derivations will afford the clue to a great many analogous words not included in his list. We should be sorry to make an ungracious remark when an author has produced a really useful work at an immense cost of labour; but we should have thought it better for Dr. M'Nicholl to have omitted the botany altogether, as it has been already well done by Prof. Henslow, in his well-known *Dictionary of Botanical Terms*, and to have devoted all his space to zoology, which he could thus have rendered more complete. We are, however, bound to say that the work is a very valuable aid to the natural history student, who is continually perplexed by difficulties which it would instantly remove.

THE WARS OF WAPSBURG, by the author of the "Heir of Redcliffe," etc., etc. *Groombridge and Sons.*—The great popularity of the "Heir of Redcliffe" will ensure a welcome for this very pretty volume, in which the manners and customs of wasps are pleasantly described under the guise of a romantic story, of which the Princess Vespa is the heroine. The illustrations are numerous and elegant, and the binding is an admirable specimen of the way in which the rich, soft appearance of morocco can be imitated in cloth.

THE DESK-BOOK OF ENGLISH SYNONYMES, by JOHN SHERER.—*Groombridge and Sons.* In this work, which the author avows to be based upon the labours of Crabbe, Richardson, and Webster, a very ingenious plan is followed, by which an unusual quantity of information is compressed in a very small space. Every word contained in the book as a "synonym" is placed in an alphabetical index referring to the page in which it will be found. By this means a great deal of repetition is avoided, and a very large body of synonyms, with the author's explanations, are given in a quarter of the space that must be devoted to them on the ordinary plan. The way to use the work is to refer to the index for the word required, and then by casting the eye down the page indicated, it will be found either as the initial word of a paragraph, or as one of its so-called synonyms. This process does not take so long as turning over the pages of a more bulky book, and will augment the utility of Mr. Sherer's labours. It is of great importance to correct writing and speaking, that the various shades of meaning embodied in what are popularly, but often incorrectly, termed synonymous words, should be accurately appreciated, and dictionaries like the "Desk-Book" will materially assist in diffusing the requisite information. We should have recommended a little more attention to primitive and derivative meanings; but the book bears evidence of much thought and reading, and the authorities followed by Mr. Sherer are in good repute.

PRACTICAL HYDROPATHY, by JOHN SMEDLEY CAUDWELL, is an elaborate account of the innumerable ways in which water may be applied as a remedial agent.

CONTRIBUTIONS TO THE ICHTHYOLOGY OF NOVA SCOTIA, by J. MATTHEW JONES, F.L.S. Privately printed. Halifax, N.S. Part I.—Mr. Jones is engaged in the useful task of ascertaining what species of fish on the N.E. coast of America are identical with those of Europe, and in this paper he shows the effect of oceanic currents in enabling certain fishes to make long journeys, and of floating masses of sea-weed in transporting littoral species, which would have not been able to migrate without such locomotive aid.

ENGLAND'S WORKSHOPS, by Dr. G. L. M. STRAUSS, C. W. QUIN, F.C.S., JOHN C. BROUGH, THOMAS ARCHER, W. B. TEGETMEIER, W. J. PROWSE. *Groombridge and Sons.*—It was a very good idea to collect together in one book a popular and readable account of many of the principal "workshops" in which manufacturing skill and industry are displayed. The establishments described range under the heads of "Metal Workshops," "Chemical Workshops," "Glass Workshops," "Provision and Supply Workshops," and "Domestic Workshops," the last title not being very appropriate, as cotton goods and pianofortes are not more "domestic" than Price's candles, or Birmingham trays. The number of establishments visited and described is forty-one, and the information, which is very pleasantly given, takes a very wide range. There are very few readers who will not be interested in these pages, but we especially commend the work to young persons entering upon the active duties of life, as they will glean from it much valuable information to direct their choice of an occupation suited to their capacities and tastes. It might also be made a very useful book for class reading in schools, as it goes deep enough into a host of technical and scientific questions to lay a good foundation, and is written in a lively, entertaining style. The enormous number of occupations requiring a large amount of scientific and technical knowledge, is one of the most remarkable features of our age, and we cannot read an account of our national labours in iron, steel, brass, and other metals, or of our great glass works and chemical factories, without being convinced that industrial necessities are compelling a very high degree of education, and leaving comparatively small chance of success for those who neglect the diligent cultivation of the mind.

OUR ENGLISH LAKES, MOUNTAINS, AND WATERFALLS, as seen by WILLIAM WORDSWORTH. Photographically illustrated. Small 4to. *A. W. Bennett.*—The admirers of Wordsworth—and they are found in all true English homes—will thank Mr. Bennett for this splendid volume. The selections from the poet, who best understood our "English lakes, mountains, and waterfalls," are very numerous, and made with great judgment, while the photographs, thirteen in number, admirably taken by Mr. Ogle, bring before us the varied beauties of the district in which he lived and wrote. The Fall of

Rydale, Dungeon-Ghyll, Langdale, Honister Crag, and Aira Force are among the most striking of the exquisite views; but the calm repose of Grasmere, the variety of Rydale Water, and the stern, feudal physiognomy of Brougham Castle, the old home of the Cliffords, all help to connect the rhyme of the poet with the objects that inspired his undying verse. We ought also to put in a word of special commendation for the initial letters and tail-pieces, which exhibit an unusual elegance of fancy, combined with artistic skill in dealing with floral forms. As "intellectual observers," we are glad to find the revival of a taste for beautiful books. Cheapness is all very well in its way, but every one, who can afford it, should endeavour to possess some specimens of favourite authors worthily treated in all that concerns paper, binding, typography, and illustration; and for those who share this feeling the volume before us has been judiciously produced.

Ruined Abbeys and Castles of Great Britain and Ireland, by William Howitt. Second Series. The photographic illustrations by Thompson, Sedgfield, Ogle, and Hemphill, fcap. 4to. *Alfred W. Bennett.*—In dealing with architectural relics of the olden time there is nothing like photography for ensuring that accuracy which is so essential to the value of archæological illustrations, and the specimens of sun pictures with which this work is adorned possess a high degree of excellence. In the frontispiece we look through the trees of the village at Kenilworth Castle, and the introduction of the landscape brings out in a striking way the magnitude and power of the grand baronial pile, associated with so many proud reminiscences of British history, associated also with much folly and crime. "Mervyn's Tower," in the same building, is admirably given, and we almost expect to see the mantling ivy wave its branches as the wind passes the window arch. Another striking picture is Whitby Abbey, one of the finest of our ecclesiastical ruins. We recognize also the elegance of Netley, and regret that tradition has done less than vegetation to add a charm to its beautiful remains. Far different is it with Croyland, whose west front makes an admirable picture, or with Lindisfarne, both of which are well known in story, and whose likeness many will rejoice to possess. Among less known ruins, we notice a highly pictorial photograph of Castlemere Priory, in Norfolk, the west front of which is a model of Norman skill. Dryburgh Abbey, so well known to the readers of Scott, affords another romantic view, quite in keeping with the sad end of the "Lady of Smailholme," as told in the "Eve of St. John." Ireland is not forgotten in the series, as we have a fine round tower in the "Rock of Cashel," and a solemn ruin in Holy-cross Abbey. The other illustrations—each worthy of separate praise—relate to Caernarvon Castle, Tynemouth Priory, Hurstmonceux Castle, Richmond Castle, Byland Abbey, Jedburgh Abbey, and Cahir Castle. There are in all twenty-six photographs, and every chapter begins with an ornamented letter, and ends with a tail-piece harmonizing with the subject of the work. Mr. Howitt has supplied a series of interesting notes on the several places, and although we should not

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like to endorse all his views of history and biography, he has performed his task in a manner that will make this beautiful book generally acceptable. The binding is very handsome, and in the centre of each cover a circular photographic view is excellently introduced. This work, like the preceding, will form an admirable present, and worthily take its place on the drawing-room table of "Homes of Taste."

PROCEEDINGS OF LEARNED SOCIETIES.

WEST BRIGHTON MICROSCOPICAL CLUB.

At a meeting of this scientific body, held on the 23rd of November last, Dr. William Addison, F.R.S., President, in the chair, the subject of Human and Animal Entozoa was discussed, especially in relation to the question as to the existence of a true nervous system in the round-worms (*Nematoda*), and as to the mode in which these parasites gain access to our bodies. Dr. Cobbold, F.L.S., of the Middlesex Hospital, exhibited the following helminths:—From the human body *Distoma heterophyes* (Ægypt); *Bilharzia hæmatobia* (Ægypt), *Ascaris lumbricoides* (England), *A. mystax* (England), *Trichocephalus dispar* (Scotland), *Trichina spiralis* (Germany), *Oxyuris vermicularis* (England), *Tænia solium* (Germany), *T. mediocanellata* (Germany), *T. nana* (Ægypt), *Bothriocephalus latus* (Switzerland), *B. cordatus* (Greenland), young of *Filaria medinensis* (India), *Cysticercus cellulosæ* (England), Scolices of *Tænia echinococcus* (England).

From animals:—*Distoma Bosci*, from an American snake; *D. coronarium*, from an alligator; *D. clavigerum*, from a frog; *D. constrictum*, from a turtle; *D. compactum*, from an Indian ichneumon; *D. varicum*, from the salmon; *Bilharzia magna*, from an African monkey; *Distoma lanceolatum*, from the ox; *Fasciola hepatica*, from the sheep; *Ascaris megalocephala*, from the horse; *A. mystax*, from the cat; *A. osculata*, from the seal; *A. retusa*, from the armadillo; *A. capsularia*, from the salmon; *Trichosoma longicolle*, from the capercaillie; *Trichocephalus affinis*, from the giraffe; *Strongylus paradoxus*, from the peccary; *Sphærularia bombi*, from the bee; *Echinorhynchus proteus*, from a salmon; *E. porrigens*, from a whale; *E. anthuris*, from the lesser newt; *Tænia pusilla*, from a rat; *T. uncinata*, from a shrew; *T. cucumerina*, *T. cœnurus*, *T. marginata*, and *T. serrata*, from the dog; *T. elliptica*, from the cat; *T. farciminalis*, from a fieldfare; *Diphyllobothrium stemmacephalum*, from the porpoise; *Pentastoma tænioides*, from a dog, and *P. multicinctum*, from a serpent; *Cysticercus* of *T. mediocanellata*, from a calf; *Echinococci*, from a lemur; adult and embryonic *Trichinæ*, from the pig; *Cysticercus fasciolaris*, from a mouse; *C. pisiformis*, from the rabbit; *C. talpæ*, from the mole; *Cœnurus cerebralis*, from the sheep; and Scolices of *Tetrarhynchus reptans*, from a sunfish.

Mr. Hennah, Hon. Secretary, also exhibited a species of *Strongylus*, from the goose; and Dr. Dawson showed some *Echinococci*, derived from a cyst in the human orbit.

ROYAL SOCIETY.—*Nov.* 30.

In his annual address on the anniversary meeting of the Royal Society, the president, Major-General Sabine, called attention to the proposed establishment of a telescope of great optical power at Melbourne, and suggested that another advantageous situation for observing the southern nebulæ would be in the Nélgiris, at elevations of several thousand feet into the clearer strata of the atmosphere.

After alluding to the measurement of the arc of the meridian at Spitzbergen, which the Swedish government propose to undertake, Gen. Sabine called attention to the circumstance of several glass bottles with closed necks having been found on the shores of the west coast of Nova Zembla. As these were conjectured to have some connection with the missing ships of Sir John Franklin, the Royal Society instituted inquiries into the subject, and eventually traced the bottles to a recent manufacture in Norway, where they are used as floats to the fishing-nets employed on the coast. These floats, accidentally separated from the nets, had been carried by the current which sets along the Norwegian coast round North Cape, and thus proved the continuation of the current to Nova Zembla. The Swedish expedition above alluded to discovered several of these bottles on the northern shore of Spitzbergen, some bearing the names of the Norwegian makers, thus supplying evidence, of great geographical value, of the extension of the Norwegian current to Spitzbergen, either by a circuitous route past the shores of Nova Zembla, or possibly by a more direct course which has not at present been traced.

In alluding to the laborious investigation of the Austrian commission on the relative advantages of gun-cotton and gunpowder for the purposes of warfare, Gen. Sabine summed up the results as follows:—

The absence of smoke, and the entire freedom from fouling of the gun, are points of great moment in promoting the rapidity of firing in casemates and between decks of ships of war. To these advantages must be added the innocuous character of the products of combustion in comparison with those of gunpowder, and the far inferior heat imparted to the gun by rapidly repeated discharges. Again, with equal projectile effects, the weight of the gun-cotton is only one-third that of gunpowder, and the recoil of the gun two-thirds, and the length of the gun admits of a diminution of nearly one-third.

Other advantages determined by the Austrian artillerists bring the power of modifying the explosive energy by varying the mechanical structure of the cartridge and the size of the chamber in which it is fired; and the fact that being a perfectly definite chemical compound, it may be stowed in damp situations, or even sub-

merged without injuring its original properties, remaining unchanged after drying in the open air, and at ordinary temperatures.

The great drawback of its liability to spontaneous combustion having now been proved to depend on imperfect manufacture, and to be altogether removed when suitable provisions are adopted in its manufacture.

At the conclusion of the anniversary meeting, the Copley medal was presented to the Rev. Adam Sedgwick, for his discoveries in geology. Royal Society's medals to the Rev. M. J. Berkeley, for his researches in cryptogamic botany, and to Mr. J. P. Gassiot, for his discoveries in voltaic electricity.

ROYAL SOCIETY OF LITERATURE.—*Nov.* 25.

Ancient Knowledge of African Lakes.—Mr. Hogg read a paper descriptive of the old maps of Africa, showing that our recently acquired knowledge was known to the ancient geographers. In a map in the possession of the College de Propagandâ Fide, at Rome, probably copied from an Arabian one of the ninth century, the Nile is represented as rising from a lake on the equator.

In a map of J. Senex, F.R.S., dedicated to Sir I. Newton, Lake Nyanza is placed in the same position as in Capt. Speke's recent map, and in Walker's map Lake Zambre is laid down in the position of the recently discovered Lake Tanganyiake. It is singular that since the time of Senex the maps have been published with continually increasing inaccuracies until the promulgation of the recent discoveries of the several African explorers. It is presumed that the information contained in these old maps must have been obtained from the Portuguese traders, who penetrated long distances into the interior.

ETHNOLOGICAL SOCIETY.—*Dec.* 9.

The Weddos, or Widdos, of Ceylon.—A description of this remarkable tribe, living in the jungle in the interior of Ceylon, was read before the Society. It was written by one of the Tamil natives. The Weddos are generally supposed to be the direct descendants of some royal families or chiefs, who were driven into the forests of the interior when the island was invaded, nearly 2200 years since.

The descendants of these families have remained perfectly distinct, not associating with the other races of the island. The males, however, exchange wax, ivory, and dried venison for salt, and also for farinaceous substances, such as arrowroot. They capture their game and defend themselves by the use of the bow and arrow, being sufficiently expert to destroy their enemies at a distance of sixty yards. They are quite ignorant of the use of firearms. Within a comparatively recent period they have commenced to cultivate the land, but they subsist chiefly on the flesh of wild animals, which they preserve in honey, and in times of scarcity they will eat decayed

wood soaked in honey. Living at a distance from the sea-coast, salt can only be obtained by them through the medium of barter, and they place a higher value on it than on any other article. They are described by the author as a miserable-looking race, speaking a dialect of the ancient Cingalese language, mixed with Talengo, and which is not understood by the Cingalese generally. Their religion consists in the worship of the tortoise Ebba, to whom offerings are made on the occasion of childbirth and sickness. If the sick person, in whose behalf the offerings are made, does not speedily recover, he or she is abandoned to die alone, the body remaining unburied. The most singular circumstance connected with the tribe is the total seclusion of the women; strangers are not permitted to approach their villages, and a father does not ever see his daughter after she has grown up, nor does a mother ever see her male children after they have attained the age of manhood.

At the time of childbirth the husband leaves his wife to the care of another female for a few days, the nurse leaving before the return of the father. Formerly the tribe appeared not to employ clothing, but more recently they have commenced its adoption.

ROYAL GEOGRAPHICAL SOCIETY.—*Dec.* 14.

Geography of Formosa.—Mr. Swinhoe, Consul at Tai-Wan-Foo, forwarded an interesting paper of notes on the Island of Formosa, which is now a Chinese province. Formosa is of very difficult access, owing to the absence of harbours, the rocky character of the coast, and the strong set of the great equatorial current, which was described by Admiral Collinson as flowing near the island at the rate of four and a half to five miles an hour.

Formosa produces excellent lignite coal, tea, jute, rice, sugar, and the general productions of a sub-tropical region. The coal was described by Admiral Collinson as being worked by means of adits, where it cropped out on the surface, no shafts being sunk. The south cape of the island was described by Sir Harry Parkes as being inhabited by a tribe of aboriginal savages, numbering about 200 or 300 people, who destroyed all strangers who were wrecked on their part of the coast; nor were those who fell into the hands of the Chinese in a much better condition, for of the crews of two large vessels wrecked on the coast in 1842, numbering 297 persons, all but twelve were judicially murdered in cold blood in the capital. Since then the island has been opened to British commerce by the Elgin treaty, and a brisk trade is being carried on by steamers between Formosa and Hong Kong.

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NOTES AND MEMORANDA.

THE AMŒBAN RHIZOPODS.—Dr. Wallich continues, with amazing patience, his elaborate study of amœban rhizopods, and we extract a few facts and opinions from his last paper in the *Annals of Natural History*. He has, amongst other things, ascertained that the amœbæ can, at least temporarily, assume the form of actinophrys. He points out three modes by which new amœbæ are formed by acts of *reproduction*.—1. The extrusion from the parent of a minute but perfect offspring. 2. Development from one of the sarcoblasts, or acapsular masses which are formed within the parent previous to, or during, encystation. 3. By development from each granule of the acapsular nuclear mass, on the disruption of the latter. He considers these creatures hermaphrodite, and that the preceding generative acts are distinct from the multiplication of the individual, or vegetative repetition of the species by fission or germination, which last process he does not vouch for on his own authority, except as regards actinophrys. He shows that sarcoblasts of the amœbæ, which are very small, do manage to get into frustules of diatoms, and he thinks they may get into confervæ, and undergo a development which has hitherto been misunderstood. He likewise proves that these sarcoblasts preserve their vitality under prolonged desiccation.

ELECTRICITY AND ASTHMA.—M. Poggioli describes to the French Academy the success which he experienced in treating asthma by electricity. He considers this remedy applicable to true asthma only, which is a nervous disorder of the respiratory apparatus, usually occurring periodically and in paroxysms, and not to asthmatic symptoms resulting from heart disease or pulmonary emphysema.

EFFECTS OF CONSANGUINEOUS MARRIAGES.—M. Balley has called the attention of the French Academy to a remarkable result of a very singular marriage of this kind. He says, "the father and mother enjoyed good health; the father was born in lawful wedlock; the mother, somewhat older, came from a foundling hospital. From this union resulted in succession four infants, stillborn; the fifth is deaf and dumb in an asylum at Rome; the sixth is a dwarf, and the seventh has not at present exhibited any peculiarity. It is now known that the individuals, so afflicted in their descendants, are brother and sister, children of the same father and mother. The girl, born before marriage, was deserted by her parents, was never reclaimed by them, and was ignorant who they were." M. Balley proposes that special inquiries should be made in deaf and dumb asylums concerning the relationship of the parents of the unfortunates. In Rome he finds out of thirteen cases of persons born deaf and dumb, three were offspring of consanguineous marriages, one being connected with the deplorable story we have just cited.

AN ARTIFICIAL TONGUE.—M. Maisonneuve, Surgeon of the Hôtel Dieu, describes in *Cosmos* how he removed from a patient the whole of a tongue afflicted with cancer, by means of which he terms *cauterization en flèches*. He perforated the tongue with eight of his cauterizing arrows (*flèches*), so as to cause all the affected portions to slough off in one mass. His patient, after the removal of the tongue, could neither swallow nor speak, but performed both those functions on being supplied with a gutta-percha tongue of the natural size.

SPONTANEOUS GENERATION CONTROVERSY.—The dispute between M. Pasteur, on one side, and M.M. Pouchet, Joly, Musset, and other heterogenists, on the other, still rages in the French Academy. The latter bring air from the Alps in bottles, and find it capable of giving rise to infusoria in solutions that have been boiled. The former admits that portions of air from Alpine summits occasionally contain germs, as proved by his own experiments, and he points out precautions that seem to have been neglected by his antagonists. The balance of experimental accuracy seems decidedly with M. Pasteur, but the continuance of the discussion cannot fail to enlarge our knowledge of the conditions under which infusoria appear. M. Flourens proposed and the Academy agreed to appoint a commission before which the heterogenists should be requested to repeat the experiments by which they think they invalidate M. Pasteur's conclusions.

ATMOSPHERIC CURRENTS AND SHOOTING STARS.—M. Chapelas, in a paper read before the French Academy, alleges grounds for believing that the movements of shooting stars are effected by atmospheric currents occurring in the higher regions to which our air extends; and he considers that these bodies may act like weathercocks and anemometers, giving us information concerning the direction and force of the winds that influence their proper motions.

BACTERIUMS AND TYPHOID FEVER.—Professor Sigri calls the attention of the French Academy to the presence of these infusoria in the blood of a man who died of the above fever in the hospital of Sienna. This fact is very curious, taken in connexion with the researches we have previously published (INTELLECTUAL OBSERVER, October, 1863, page 177).

KIRCHHOFF ON SUN SPOTS.—The memoirs of the Berlin Academy contain M. Kirchhoff's papers, of various dates, on the Solar spectrum, and it appears that he attributes sun spots to a cooling action exerted by clouds which obstruct the radiation of heat from the solar surface (which he imagines incandescent), and thus reduce a portion of the atmosphere immediately over the cloud to a temperature below the point necessary to render it luminous. The spots, according to this hypothesis, are portions of solar atmosphere cooled below red heat, and above them, portions which have been cooled somewhat less constitute the penumbra. It may be doubted whether this explanation will be found to fit the actual phenomena. Such coolings would cause powerful and peculiar currents. Do exactly such currents occur as would result from M. Kirchhoff's supposition, and are they evidenced by the behaviour of the spots?

DISTANCE OF SIRIUS.—As Sirius now forms a magnificent object in our heavens, we transcribe from *Cosmos* a few interesting remarks by M. Camille Flammarion, who says, "thanks to the labours of Sir John Herschel, we know that the absolute intensity of the light of Sirius has been estimated at 224 times that of the sun, and that its parallax, amounting to 0″·23, gives for its distance from the earth the probable number of 52 billions of leagues. It follows that we do not see the Sirius of to-day, but of twenty-two years ago: the ray of light that we receive to-day having been emitted by the star about 1840."

AZULENE.—Mr. Septimus Piesse has discovered a substance to which he has given this name, in several "ottos," or essential oils. It is a blue liquid, and produces a blue vapour on ebullition. It is soluble in fatty and volatile oils, and in most liquids except water. It bears a temperature of 700° or 800° F. in a sealed tube without alteration, and only the strongest chemicals, with the aid of heat, effect its decomposition. Sir D. Brewster reports that two blue oils containing azulene—*Matricaria chamomilla* and *Achillea millefolia*—absorb the light between lines A and B of the spectrum more powerfully than in the portions adjacent to them. Blue otto of chamomile yields one per cent.; otto of wormwood three per cent., and otto of patchouli six per cent. of azulene.

MR. HIGHLEY'S LANTERN POLARISCOPE.—Mr. Samuel Highley has just introduced a form of polariscope easily used with a magic lantern, and capable of producing a variety of beautiful and startling effects. The light is polarized by reflection from a bundle of glass plates placed at a suitable angle, and the general arrangements are sufficiently simple and economical to be of wide use both for the purposes of instruction and entertainment.

M. PASTEUR ON WINE-MAKING.—M. Pasteur finds that grape-must does not contain oxygen gas in solution, but only carbonic acid and nitrogen; that if the must is left in contact even with a large surface of air it does not oxydize, so that until fermentation begins, it contains only carbonic acid and nitrogen; but the oxygen of the air combines with it in proportion to its dissolution with oxydible principles naturally contained in grape juice. The combination of the oxygen is not, however, so rapid but that we may find the gas in solution some hours after the must has been agitated in contact with air. The oxydation modifies the colour of the wine, giving the yellow tint to the juice of white grapes, and browning that of the red, and it also appears connected with the formation of the ether of wine. Guy Lussac showed that oxygen was necessary to the fermen-

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tation of grape juice; and M. Pasteur states that if the must is artificially aërated it ferments much more rapidly. He considers that in certain cases this artificial aëration might be beneficially employed, especially when wine remains too sweet after a tumultuous fermentation. When wine is put in casks the oxygen of the air reaches it through the wood, with more or less rapidity, according to the thickness of the staves, the warmth of the cellar, etc. Without this action M. Pasteur considers it would remain *new* wine, green, harsh, and not fit to drink. When the wine is bottled the facility for oxydation is greatly diminished. It might be possible to accelerate the oxydation in casks so as to ripen the liquor sooner, but, as M. Berthelot has shown, rapid oxydation produces mischievous effects.

The 2nd and 3rd December Storm.—M. Marié-Davy states that on the 1st December this great storm was 50 or 60 leagues from the N.W. coast of Ireland, at 8 a.m. On the 2nd December, at the same hour, its centre was at Shrewsbury, and the cyclone, instead of its following its customary march towards the east, was bent back towards the south. In Paris the barometer fell with extreme rapidity, and the tempest raged in that city with great violence. Twice since the first fortnight in November a hurricane traversed England and France almost from north to south, and it seemed as if this were about to happen the third time, when about one o'clock the barometer rose as quickly as it fell, and the storm took a northward course. The southern movement was not, however, completely arrested, and a violent wind blew in the gulfs of Lyons and Genoa, and in the Adriatic. On the 3rd December, the centre of the hurricane in England was near York, from whence it moved in its habitual course towards the east. On the 4th, it was a little north of Copenhagen; on the 5th, it appeared to quit the Baltic, between Libau and Königsberg, after which its course was not traced at the date of his paper. The centre of the hurricane moved with a velocity of ten leagues an hour, being the rate at which slight cyclones often move across Europe. It will thus appear that the cause of their progress is independent of their violence. M. Marié-Davy considers that this storm may have started from the Gulf of Mexico, and he suggests that if a telegraph cable should ever join Europe and America, and pass the Azores, those islands would make an excellent station, from which we might have two or three days' warning of the coming of great storms.—*Comptes Rendus.*

M. Blondeau on Acetification.—This observer tells us that if casein be added to a saccharine solution, mycoderms are developed, and acetic acid formed. Referring to M. Pasteur's statements concerning the acetifying action of certain mycoderms, M. Blondeau remarks that his experiments show that the plants perform this function only when they assume a membranous form, and that the property of taking oxygen from the air, and with it transforming alcohol into vinegar belongs to the membrane as such, and is not a physiological action.—*Comptes Rendus.*

Supposed New Planet.—It was announced that M. Schmidt had discovered a new planet on the 13th November. He found it a little east of η in the Pleiades, and it appeared of 10th to 11th magnitude. In a subsequent number of the *Astronomische Nachrichten* that astronomer states that, according to the supplement to the *Nautical Almanack* for 1866, the little body appears to be Hygeia. On the 18th November it was very faint, and about 12th magnitude.